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# The Mining Magazine

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# The Mining Magazine

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# EDITORIAL

IN time for the commencement of the new academic year a new edition of "An Introduction to Mineral Dressing," by E. J. Pryor, makes its appearance. Published by Mining Publications, Ltd., the revised and greatly enlarged text has been retitled "Mineral Processing" in line with present-day thinking on this subject. The period since the earlier edition has seen much expansion and research, while a degree course in the subject has been founded at the Royal School of Mines, where Dr. Pryor is the University of London reader.

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RECENTLY issued by the Australian Bureau of Mineral Resources is Report No. 46, which deals with the Badgeradda area of the southern part of the Carnarvon Basin, which has attracted so much of the attention of those engaged in the search for oil in Western Australia. The area covered, some 1,500 sq. miles in extent, is underlain mostly by Precambrian and Lower Palaeozoic rocks, covered in places by a thin veneer of younger beds. The survey has shown that the area has no oil potential in itself, but suggests that the knowledge of the rocks and their structures will aid in interpreting sub-surface geology in other parts of the basin since studies of this kind are important in building up a picture of geological history which may yet be of economic importance.

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THE annual report of the Tanganyika Geological Survey Department for 1959 [1] (Part I) emphasizes the fact that no country can advance rapidly beyond a subsistence economy without the proper exploitation of its mineral resources. The report points out that the regional geological mapping of the Territory, the prime function of the Survey, was continued during last year and although staff shortages were again a limiting factor reasonable progress was maintained. It goes on to say, however, that "provision of the finance necessary to achieve progress within this framework is probably not available locally and may require to be sought outside Tanganyika. There are good hopes of finding fresh mineral deposits of economic importance within Tanganyika; the geological structure and mineralization of large areas are virtually unknown except in a very general way." It is suggested that mining companies are to-day reluctant to embark on costly large-scale projects of lengthy duration in little-known areas, but obvious that existing conditions require an extension of the work of the Survey to the point where capital will be attracted to enter the field. The presence of carbonatite bodies containing pyrochlore and other metals, however, and the possibility of new diamondiferous deposits, both as kimberlite bodies and alluvial deposits, and the widespread occurrence of copper mineralization give hope that the mineral development of the territory will make a significant and material change in its national income.

[1] Dar es Salaam: Government Printer. Price Sh. 3/–.

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## Safety in Mines Research

Earlier this month the report of the Safety in Mines Research Establishment of the Ministry of Power for 1959 became available. As is but natural in this country most of the exposition relates to coal-mining matters, but it can be noted that in the year under review an "Incidents Section" has been set up, since much of the work of the Establishment is concerned with investigations of actual incidents and the new section co-ordinates this work and provides men specially trained in scientific aspects of mine disasters. Problems associated with haulage and suspension gear are prominent in the report on engineering research. The strength of components is often specified, it is suggested, by saying that the ultimate strength must be not less than so many times the working static load, not a reliable method if unsupported by detailed stress calculations, since failure may be by fatigue and not by simple static loading. In the section studying pneumoconiosis much interest is being taken in the development of a gravimetric sampler for measurement of respirable dust. It is thought that measuring the mass concentration of such dust may ultimately prove more useful and more convenient than the current practice of measuring the particle-number concentration. Tribute is paid to the co-operation of foreign workers, a particularly valuable exchange of ideas

taking place at the Tenth International Conference of Directors of Safety in Mines Research in Pittsburgh.

## The Report of H.M. Chief Inspector for 1959

Those parts of the report of H.M. Chief Inspector of Mines and Quarries for 1959 dealing with minerals other than coal makes, all in all, unexciting reading.[1] With the exception of mines working anhydrite and potter's clay, it is noted, trade has been slack and a number of properties working lead, fluorspar, and barytes were closed down. However, referring to "Mines of Stratified Ironstone, Shale, and Fireclay," the Inspector points out that the most important of the 121 mines listed under this heading are those of stratified ironstone in Northampton and Lincoln and in the North Riding of Yorkshire, together with oil-shale mines in Scotland and a number of fireclay mines. In the Midlands, it is stated, seven ironstone mines were at work during the year; two of them opened towards the end of the preceding year were still in process of development. More diesel locomotives are being used in these mines, which are becoming increasingly mechanized. In the Cleveland district three mines remained at work, producing slightly over 400,000 tons of ore, as compared with about 500,000 tons in the previous year. The production of some 700,000 tons of oil shale in Scotland showed a drop of 4·4% as compared with 1958 and an experiment designed to test the possibility of producing mineral oil from oil shale *in situ* was unsuccessful and had to be discontinued. The Inspector says that there appears to have been a considerable reduction in output from the fireclay mines. On the whole work continued on traditional lines, the bulk of the output being obtained from pillar and stall working and most of these mines are comparatively small and shallow.

When it comes to open-cast work, particularly in the quarrying industry, the Inspector points out that of the various technical advances now being made probably the most rapid are in drilling and in the use of explosives. For several decades, he says, only minor developments occurred, with the result that many quarries continued to use drilling patterns and blasting methods not really suited to the deposits being worked. Nowadays, however, there is a large range of reliable and adaptable drilling machines from which to choose, many types of which can drill holes efficiently at all angles and at various diameters. One feature now common to many of the modern machines, it is noted, is their capacity to drill angled holes to substantial depths without significant divergence. This has enabled many quarries to improve their face conditions by adopting the off-vertical system of primary blasting. Any loose stone left on the face after a blast can be much more easily and safely dealt with.

[1] London: H.M. Stationery Office. Price 4s.

## Mining Outlook in Canada

In a report recently issued in London it is suggested that "a mood of doubt" now prevails in mining circles in Canada.[1] The report pays tribute to one of Canada's famous gold mines, Hollinger Consolidated, which reached its 50th year of life this June, with a record of having produced gold bullion valued at $500,000,000 and having paid out $152,000,000 in dividends. However, earlier this year, it is noted, another of the famous gold mines of Ontario, Kerr Addison, caused "sudden dismay" by announcing that the end of its ore reserves was in sight, while late in July a third, smaller, gold mine announced it would go upon a salvage basis, being out of ore. The report records that gold production in Canada in the first four months of this year was slightly higher at 1,503,127 fine oz. than in the similar period of 1959 and, as the price of the United States dollar on which the price of gold in Canada is based has been rising, the return to the mines has been even greater. In spite of this the Bank reports that there is now comparatively little interest in the search for new gold mines, neither is there the urgent interest in discovery of base-metal ore-bodies, even though total mining dividends to June this year, at $28,000,000, were 16% higher than for the corresponding period of 1959. In part world conditions are responsible but another factor, it is suggested, lies in conditions peculiar to Canada. For instance, as regards uranium, exports up to mid-year were even with last year at $26,000,000, but the United States decision not to take up future options has left the industry "depressed and confused," while a more recent British announcement of a slowing down of atomic power development has offset evidence that

[1] Barclays Bank *Overseas Review*, Aug., 1960.

Canadian producers were reducing mine costs. One further cause of doubt as to the international market has been the effort by political interests in the United States to obtain a larger share of the lead-zinc market for marginal United States mines.

The mining fraternity, the report goes on to say, also had had its enthusiasm for exploration and development damped by domestic changes. The cost of mine operation has continued to mount, as miners' unions have become stronger, while a stricter interpretation of taxable income has lessened the opportunity for promoters to make large tax-free capital gains. At the same time, however, while mining shares sag in the stock market and promoters talk pessimistically, there is healthy activity both in the consolidation of interests to make stronger companies and in exploration by the large companies. Most significant of all, it is pointed out, is the fact that substantial sums from seasoned overseas investors in mining exploration have recently been entering Canada.

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## Tin Restriction Goes

Following their meeting in August the International Tin Council announced that all restrictions on permissible exports have been removed for the last quarter of the current year. As our Metal Markets correspondent notes elsewhere in this issue, this means for the first time in three years the metal market is to be free to move without interference in response to the influences of supply and demand. According to the official announcement the change has been made because of the statistical position of the metal. It is the view of the Council apparently that some producing countries are now dipping into their stocks, which, it is thought, are in some cases very low. It is indeed the view of the market that while restriction was not expected to end so soon it is welcome in present circumstances.

In the main producing countries the end of restriction has been welcomed heartily. It is, however, to be noted with concern that no new tin areas have been discovered in recent years and that expanded outputs must come from shrinking resources. The time has surely come for countries such as Malaya to foster new exploration campaigns in likely areas and so to encourage an important industry the better able to look to the future.

## Gold Mining in Western Australia

Speaking at the 59th annual general meeting of the Chamber of Mines of Western Australia held in Kalgoorlie on May 24 the late Mr. R. J. Agnew, then President of the Chamber, said that no advances had been made to the Federal Treasury during 1959 regarding the advisability of a gold subsidy. When the time was considered appropriate, however, it was intended to approach the Government again to suggest that the gold-mining industry should be supported "on broader lines" than those in operation at the present time. The Chamber still felt, he said, that it was "better to give assistance to the industry while it is still in a position to help itself rather than wait until it has got to the subsidy stage, when it is a much more doubtful issue as to whether a property will be able to rehabilitate itself. The small amount of assistance needed to enable a mine which is operating at a profit on its own account to develop sufficiently to keep its reserves well ahead of its mill requirements is well warranted and would pay handsome dividends to the country in the form of extra gold production and extra employment." The payment of subsidies to companies in difficulties and where subsidies were needed to keep them actually in operation and with some chance of their rehabilitating themselves to the point where they could eventually stand on their own feet, Mr. Agnew said, lent thought to the idea that the Treasury was mainly concerned with the distribution of population in the State rather than in the production of gold. While the Chamber was interested in the distribution of population it maintained that on the long-term view the industry should be encouraged to produce as much gold as possible during its life-time.

In the year under review 2,959,202 long tons of ore were treated by Western Australian mines for a yield of 860,969 fine oz. of gold, the value of which amounted to £13,452,643. The figures quoted show a decrease in tonnage of 61,870 compared with the previous year and a decrease of 13,850 oz. The gold recovered per ton was 5·82 dwt. as compared with 5·79 dwt. for the previous year. In the year the Gold Producers' Association made two distributions to a total amount of £A1,396, which brought the total paid out since the formation of the Association to £A1,878,196.

# MONTHLY REVIEW

**Introduction.**—In spite of the uneasiness created by world affairs in general and the African situation in particular industrial expansion continues to sway business sentiment. As has been the case so often over previous months commodity prices, including base-metal quotations, remain surprisingly firm.

**Transvaal.**—The output of gold from the Rand and Orange Free State mines continues to expand, the figures for July showing a production of 1,776,141 oz., making with 39,673 oz. from outside producers a total of 1,815,814 oz. for the month. At the end of July there were 378,626 natives at work in the gold mines, as compared with 380,593 at the end of the previous month.

A stope fire at the BUFFELSFONTEIN mine last month was sealed off, the rest of the mine continuing normal operation.

Shareholders of WESTERN AREAS GOLD MINING were informed last month that the Ventersdorp Contact Reef had been intersected in the ventilation shaft at 3,327 ft. below collar. It assayed 67 in.-dwt. and was followed by mineralized conglomerate bands of the Elsburg Series intersected between 3,334 ft. and 3,356 ft., all the reefs dipping in a southerly direction. The reefs were sampled at 5 ft. intervals around the circumference of the shaft and averaged some 160 in.-dwt. in value. As was anticipated, the dips of the Ventersdorp Contact Reef and of the Elsburg Series indicated that they are not conformable. A station was cut at 3,360 ft. and development incidental to the station layout passed through the Ventersdorp Contact Reef and certain of the horizons of the Elsburg Series which had been intersected in the shaft. Although the various mineralized bands intersected in the shaft and in the station development are well defined, no final correlation, it is stated, has been made.

Reef intersections have also been reported by WESTERN DEEP LEVELS and LESLIE GOLD MINES. At the first-named property the Ventersdorp Contact Reef was cut in a cross-cut from the No. 3 shaft system on 66 level (approximately 6,000 ft. below surface). The Reef, which was dipping in a south-easterly direction at 31°, was exposed over 15 ft. and, when sampled, gave an average value of 59·50 dwt. a ton over a channel width of 23·83 in. At Leslie the No. 1A shaft intersected the Kimberley Reef at 1,476 ft. below collar, sampling around the whole perimeter giving 80·9 dwt. over 5·6 in.

**Orange Free State.**—A series of reef intersections has also been reported from several Free State mines in the past month. At FREE STATE GEDULD, for instance, the Basal Reef was cut in the No. 1A Ventilation shaft at 4,544 ft. below collar dipping north-east at 15°. Assays showed 239·51 dwt. over 9·06 in. Intersections at PRESIDENT STEYN GOLD MINING were made in both the Main and Ventilation shafts in the first case in a faulted zone. In the Ventilation shaft the Basal Reef was cut at 4,579 ft. below collar and averaged 13·87 dwt. in gold and 0·253 lb. of uranium oxide per ton over 12·62 in. Finally, at PRESIDENT BRAND Borehole M.G.4, situated 3,050 ft. south of No. 2 shaft, intersected the Basal Reef at 6,092 ft., assaying 26·9 dwt. of gold a ton over a corrected width of 13·2 in. Core recovery was complete and no deflection is to be made.

In the August issue reference was made to the intention of FREE STATE SAAIPLAAS GOLD MINING to increase its capital. A circular to shareholders at the end of the month gave particulars of an offer of 3,000,000 of the new 10s. shares at par. At the necessary extraordinary meeting of the company held in Johannesburg on August 17 the chairman referred to recent development progress, saying that " in July the total advance . . . amounted to 7,507 ft. The footage sampled totalled 1,335 ft. of which 950 ft. . . . proved payable at an average value of 6·3 dwt. per ton over an estimated stoping width of 50·6 in., equivalent to 319 in.-dwt. These data indicate a continuation of the upward trend in the percentage payability and in the average payable value disclosed by development during recent months. Connexions between No. 1 shaft and No. 2 shaft have now been effected underground on both No. 7 level and No. 9 level and preparations for stoping are in hand."

**Southern Rhodesia.**—With the recent dividend notice shareholders of the CORONATION SYNDICATE were informed that the profit of the company for the year ended June 30 last, after taxation, was £102,074.

**Northern Rhodesia.**—The consolidated quarterly report of RHODESIAN SELECTION TRUST for the three months to June 30 last shows that the estimated profit attributable to the company in the year to that date,

before providing for taxation, was £6,644,000, a figure which compares with £4,701,000 for the previous year. At MUFULIRA COPPER MINES sales of the copper for the year totalled 103,040 tons, the estimated profit in this case, again before taxation, being £8,749,000. The figures for CHIBULUMA MINES show 22,485 long tons of copper and 715 tons of cobalt for a profit of £1,784,000.

ROAN ANTELOPE COPPER MINES sold 91,051 long tons of copper in the year to June 30 last and made a profit of £6,839,000 before providing for taxation.

**Ghana.**—In the three months ended June 30 last BREMANG GOLD DREDGING treated 2,717,100 cu. yd. of ground and recovered 16,908 oz. of gold. The report says that capital expenditure during the quarter amounted to £10,538. No. 1 dredge was out of commission from June 20 to July 3 for major repairs, while flooding caused considerable inconvenience towards the end of the quarter.

**Sierra Leone.**—It is reported from Freetown that the DIAMOND CORPORATION (SIERRA LEONE), LTD., is to prospect for gold and platinum and that an agreement has been signed between the Corporation and the Government to this effect. The Corporation is also to investigate what deposit of diamonds still exist in the disused swamps and terrace gravels outside the SIERRA LEONE SELECTION TRUST lease areas. In the first instance, it is stated, the Corporation is to assist the Government's Mining and Geological Departments in prospecting works in different parts of the country. The Corporation will be permitted to mine gold and platinum if deposits are found to be economically workable, but will not be allowed to mine any diamonds. Any diamonds recovered during prospecting or in subsequent exploitation will be sold through the Government Diamond Office and proceeds of sale refunded to the Diamond Corporation up to the amount of their expenses.

**Nigeria.**—In his statement accompanying the report and accounts of CONSOLIDATED TIN SMELTERS for the year ended March 31 last the chairman referred to negotiations for a renewal of the company's contracts for Nigerian tin concentrates. At the annual meeting on September 8, however, he announced that a change had since occurred. He said that the Government of Nigeria had expressed the wish that a domestic tin smelter should be built in Nigeria to treat locally-produced tin concentrates. In the circumstances the company has decided to proceed with the installation of a tin smelting plant on the Jos Plateau in Northern Nigeria, and to form a company in Nigeria for that purpose. It will be recalled that mention was made of a new smelting company in Nigeria in our July issue.

**Australia.**—At the end of August shareholders of the CONSOLIDATED ZINC CORPORATION were informed of the decision of the Federal Government to sell the aluminium works at Bell Bay, Tasmania, in an announcement by Senator W. H. Spooner, Minister for National Development. The purchase price is £10,973,000, of which £2,500,000 is to be paid as a deposit and the remainder in instalments over some 16 years. A new company is to be formed with a capital of £A10,000,000 to take up the assets, with Consolidated Zinc having a two-thirds interest and the Tasmanian Government one-third. At present the Bell Bay plant is operated by the Australian Aluminium Production Commission set up by an agreement of 1944 between the Commonwealth and Tasmanian Governments. It produces aluminium ingot and some alloys and special shapes, its capacity being 12,500 tons of ingot per annum. The plant is at present being expanded to a capacity of 16,000 tons of ingot per annum, the Tasmanian Government providing most of the funds for this purpose. However, the Senator said, a much higher production rate than this is needed, involving substantial new investment not only in the plant itself but also by the State Government in electricity supplies, housing, and utility services. In addition the discovery of the bauxite deposits at Weipa and Gove in Northern Australia and the investigation of other deposits, including those in the south-west of Western Australia provide the basis for the development of a major industry in Australia based on the production of aluminium and fabricated products.

Last month the CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LTD., announced that, through its subsidiary company, the GOLD FIELDS AMERICAN DEVELOPMENT COMPANY, 3,500,000 shares of the unissued capital of COMMONWEALTH MINING INVESTMENTS (AUSTRALIA) were to be subscribed in cash at par (10s. Australian), subject to the approval of that company's shareholders at an extraordinary general meeting to be convened shortly. The present issued capital of Commonwealth Mining is £A1,451,500 and its interests are predominantly in gold,

copper, and zinc undertakings in Australia. The successful conclusion of the arrangements contemplated, which will, it is stated, result in Commonwealth Mining becoming a subsidiary company in the Gold Fields group, will enable Commonwealth Mining to undertake a further expansion of its business ; at the same time it will substantially increase the interest of the Gold Fields group in the Australian continent.

With the recent dividend notice shareholders of MOUNT MORGAN, LTD., were informed that subject to the completion of audit the profit for the year to June 26 last was £A425,712, after providing £A175,000 for depreciation.

The directors of the WESTERN MINING CORPORATION last month reported that the profit for the financial year ended March 31 last was £A255,380 (last year £A308,444). The consolidated profit with its subsidiaries was £A640,638, of which £A334,189 was attributable to the company from its own profits and its interests in the profits of subsidiary companies and £A306,449 to the interests of minority shareholders.

Advance information issued by the MOUNT LYELL MINING AND RAILWAY COMPANY regarding the year to June 30 last shows a profit of £403,062 after charging for development and exploration £72,312, for depreciation £135,397, and allowing a provision for taxation of £30,000.

**Fiji.**—Earlier this month the directors of EMPEROR MINES announced that arrangements have been made with LOLOMA (FIJI) GOLD MINES and DOLPHIN MINES for the purchase by the operating subsidiary—EMPEROR GOLD MINING CO., LTD.—of all the remaining mining interests in Fiji of Loloma and Dolphin, covering stores, plant, housing and mining leases. The purchase is to be effected by the issue at 5s. per share (including a premium of 4s.) of 234,000 shares of 1s. each in Emperor Mines to Loloma (Fiji) and 78,000 shares of 1s. each in Emperor Mines to Dolphin Mines.

**Indonesia.**—Reference to the speech made by the chairman of CONSOLIDATED TIN SMELTERS at the annual meeting has already been made, but a further pronouncement is of interest. He said that " stockholders may be aware that the Government of Indonesia has decided for political reasons that they will no longer ship any part of their production of tin concentrates to Holland for smelting. A contract has therefore been signed under which these concentrates are being delivered to Malaya for smelting by the STRAITS TRADING CO., LTD. By an arrangement with that company a proportion of these Indonesian concentrates is being treated by our subsidiary, EASTERN SMELTING CO., LTD."

**Malaya.**—Shareholders of PETALING TIN were recently informed that the areas previously worked by Nos. 3 and 4 dredges still contain economic values below digging depths and that preparations are in hand to work part of the areas by open-cast methods, employing a bucket-wheel excavator. Application has been made to the Controller for an assessment as a new mine under the Tin Control Regulations and the project (together with the liquidation of the bank overdraft) is being financed by the sale of part of the company's investments, as these funds can thus be more profitably employed.

SUNGEI KINTA TIN DREDGING is also to start open-cast mining. At the recent annual meeting the chairman said dredging operations are becoming increasingly unattractive, particularly in respect of the new fuel oil tax.

The report of KINTA KELLAS TIN DREDGING for the year to March 31 last shows a profit of £28,000 and a total of £53,083 available, of which a dividend equal to 5% requires £3,216. In the year 277 tons of concentrates were produced from 1,601,000 cu. yd. of ground treated.

The effect of the end of restrictions for the current quarter is that many dredges closed down for a period will be re-opened.

**Thailand.**—A circular to shareholders of TONGKAH HARBOUR TIN DREDGING issued at the end of August gives the latest information regarding values in the Bhuket Harbour sea leases, in which ore reserves are estimated as 4,640,000 cu. yd. in the inner harbour averaging 0·33 lb. of tin per cu. yd. and 2,102,000 cu. yd. in the outer harbour averaging 0·41 lb. In the Ronpibon Section it is estimated that there are 36,063,000 cu.yd. averaging 0·73 lb. per cu. yd. On the sea leases the ground dredged to date has extended in a northerly direction from the southern boundary of the leases. The results to date show that the sea dredge " is an efficient unit entirely suitable to treat the area in which it is at present located but, in view of the large area covered by these leases, and the relatively short period so far worked, it is impossible as yet to form any estimate of the payable reserves within the leases held. In the meantime the dredge will continue to work in these leases for the time being so long as the present profitable opera-

tions continue and subject to the limitations of production by Export Control."

**Portugal.**—With the recent dividend notice shareholders of BERALT TIN AND WOLFRAM are informed that the profit for the year to March 31 last is £212,864, after providing for Portuguese taxation.

**Peru.**—In an interim report issued last month the stockholders of the CERRO DE PASCO CORPORATION were informed that for the first half of the current year the consolidated net income before depletion totalled $5,284,124, or $2·00 a share, as compared with $3,076,444, or $1·17 a share on a slightly lesser number of shares, in the corresponding period of 1959. Sales amounted to $84,045,928 in first half of 1960, against $70,860,479 in the 1959 period.

**United Kingdom.**—As noted last month the operations of GEEVOR TIN MINES in the year ended March 31 last resulted in a profit of £58,463. In the year 65,662 tons of ore was milled and 648·48 tons of black tin produced. Ore reserves at the end of March were estimated as 190,990 tons. The report says that, speaking generally, development has been disappointing, difficulties having been further increased by the fact that recent investigation has shown that the sea has entered the undersea workings of the old Levant mine. As the ore-shoots pitch to the west this had the effect of severely restricting development possibilities in that direction. Diamond-drilling operations have been started and are being continued during the current year, the purpose of the first holes drilled being to test the extension of some of the known lodes.

**Consolidated Tin Smelters.**—The consolidated accounts of Consolidated Tin Smelters for the year ended March 31 last show a profit of £324,524 and £559,646 available for distribution. Of this amount £50,000 has been placed to reserve and £54,000 taken for preference dividends, while a dividend and bonus equal to 3s. 6d. on the ordinary shares require £214,211.

**Contin Mining and Finance Co.**—In the year to June 30 the total earnings of Contin Mining and Finance and its subsidiary before taxation amounts to £34,966, less taxation £12,121, leaving a net profit of £22,121. The balance brought forward from the previous year after taxation adjustment was £28,248, making a total of £50,369. After providing for an estimated loss on the amount due by the CONSOLIDATED TIN MINES OF BURMA, LTD., of £25,000, there was a balance of £25,369. A dividend of 12½% will absorb £14,635, leaving a balance carried forward of £10,734.

## DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated)

†**Beralt Tin and Wolfram.**—2s.

***British South Africa Co.**—2s., payable Oct. 20.

***Central Provinces Manganese Ore Co.**—1s. 2d., free of tax, payable Oct. 1.

†**Contin Finance and Mining Co.**—12½%, payable Oct. 13.

†**Coronation Syndicate.**—4d., payable Oct. 6.

***El Oro Mining and Exploration Co.**—7%, payable Oct. 31.

***Falcon Mines.**—6d., payable Nov. 10.

†**Free State Geduld Mines.**—5s., payable Nov. 3.

***Geco Mines.**—25 cents, payable Sept. 30.

†**Lydenburg Gold Farms.**—3d., payable Oct. 27.

†**Mount Lyell Mining and Railway Co.**—Ord. 3¾d., bonus 1¾d., payable Oct. 15.

†**Mount Morgan.**—1s. Aust., payable Sept. 30.

†**New Witwatersrand Gold Exploration Co.**—6d., payable Oct. 27.

***Normetal Mining Corporation.**—5 cents, payable Sept. 30.

***Petaling Tin.**—4·2d., payable Sept. 19.

†**Powell Duffryn.**—Ord. 10%, payable Oct. 10.

†**President Brand Gold Mining.**—3s., payable Nov. 3.

†**President Steyn Gold Mining.**—1s., payable Nov. 3.

***Quemont Mining Corporation.**—20 cents, payable Sept. 30.

†**Transvaal and Delagoa Bay Investment Co.**—2s. 4d., payable Sept. 21.

†**Welkom Gold Mining.**—4½d., payable Nov. 3.

†**Western Holdings.**—5s. 6d., payable Nov. 3.

†**Witbank Colliery.**—1s. 4d., payable Sept. 22.

## METAL PRICES

*Sept. 8.*

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

| | £ | s. | d. |
|---|---|---|---|
| Aluminium (Home) | 186 | 0 | 0 |
| Antimony (Eng. 99%) | 190 | 0 | 0 |
| Chromium (98%–99%) | | 7 | 2 |
| Nickel (Home) | 600 | 0 | 0 |
| Platinum (Refined) | 30 | 5 | 0 |
| Silver | | 6 | 7½ |
| Gold | 12 | 10 | 5 |
| Wolfram (U.K.) | | | |
| (World) | 7 | 18 | 0 |

Tin, Copper, Lead, Zinc } See Table, p. 176.

# Photo-Draughting

A new way to use photography in engineering work

S. D. Michaelson
and B. H. Ensign[1]

Photodraughting or, more correctly, photodrawing, is a new way to use photography in an existing plant for making a low-cost installation drawing which, in some ways, is better than a conventional drawing. The technique uses one or more planned photographic positives on which all pertinent facts, figures, or line layouts are drawn. This replaces the usual detailed engineering drawing. The basic techniques can be used for a wide variety of engineering-design changes in an existing plant. An obvious and perhaps "over simplified" use is for engineering installations of small equipment or piping.

Two projects have been completed using photodraughting and several others are being engineered. The completed projects covered the engineering of vacuum-cleaning systems for crushing plants—one for the Chino mill at Hurley, New Mexico, the other for the mill at Magna, Utah. Although they were similar the Chino project was more complex because outlets had to be provided at so many different elevations as opposed to relatively few different levels for the Utah job.

The Chino project was done first. This particular plant is more than 35 years old and the plant drawings, many dated in 1924, did not show the numerous plant additions, deletions, and changes made over the years. As a result no usable set of "as-built" drawings was available.

Field measuring and engineering time needed to bring the old drawings up to date would have been costly and a delay to the job completion. Therefore it was decided to investigate other simpler design techniques and photodraughting looked best. With the technique outlined the job could go forward without delay and still provide the information that would allow the plant engineers to revise the old drawings at a later more convenient time.

Encouraged by the success on the Chino job a search was made to determine which other projects could be done more economically by photodraughting. A new vacuum-cleaning system was needed in the primary and secondary crushing plants of the Magna mill and this was one of the projects which provided the medium for working most of the "bugs" out of the photodrawing method.

For both projects a marked print provided by the plant engineer was the starting point. On this preferred locations for the vacuum-system inlets were shown. The project engineer made a preliminary study of the job, first in the office, then in the plant, to confirm that photodraughting would work and to plan and take the necessary pictures.

The photography was planned so the pictures could be arranged in logical sequence on the final "drawing" sheets, with a few extra "shots" taken to ensure complete coverage. Each picture was identified by a numbered placard positioned for easy visibility in the area being photographed (see Fig. 1, Drawing U50-09-102). At the same time adequate identifying data—such as, column line, elevation, etc.—were entered on a log sheet for use when assembling the individual photos.

On the Chino project a 4 × 5 camera with a 135-mm. lens was used. On the Utah project an 8 × 10 camera with a 190-mm. wide-field lens was tried. (On this latter job a professional photographer took the pictures under the direction of the project engineer.) Any reliable camera can be used; however, greater control and precision can be obtained from pictures taken with a view-type camera instead of a standard hand-held camera.

The camera should be tripod-mounted for best results, particularly if poor light conditions necessitate slow shutter speeds. Before taking a picture the subject field must

[1] S. D. Michaelson is chief engineer and B. H. Ensign a staff engineer of Kennecott Copper Corporation, Western Mining Divisions Engineering Department, Salt Lake City, Utah.

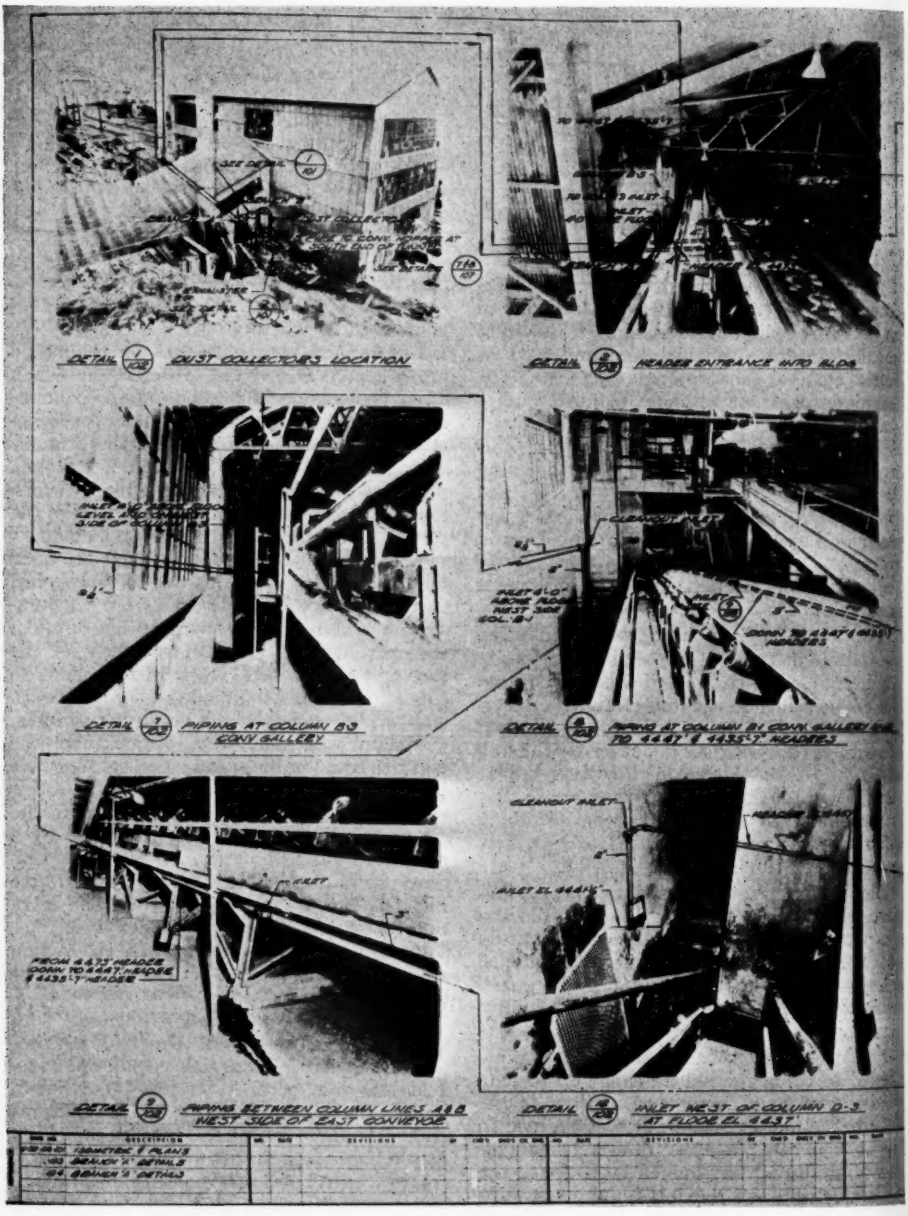
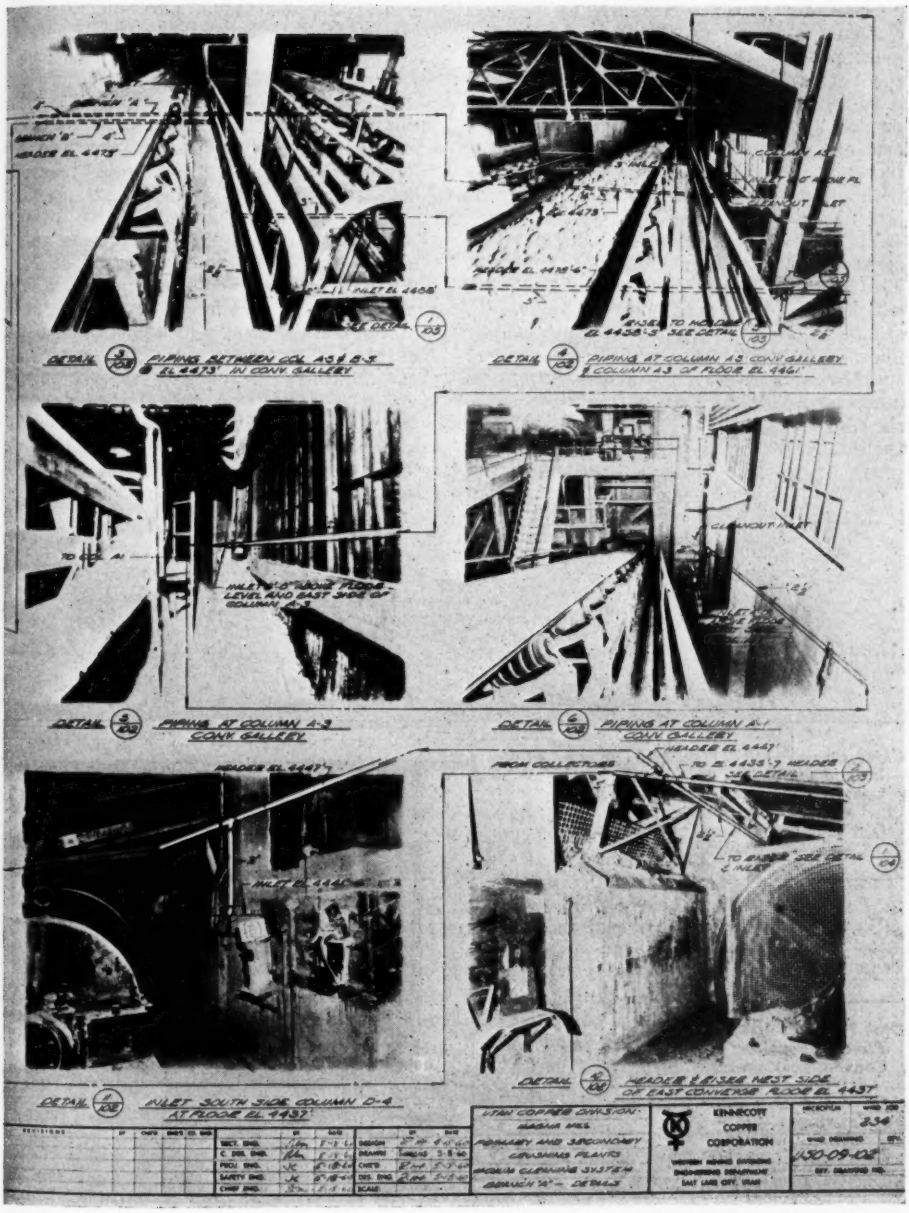



Fig. 1.—Drawing


DETAIL 3/108 PIPING BETWEEN COL A3 & B-3 @ EL 4473' IN CONV GALLERY
DETAIL 4/108 PIPING AT COLUMN A3 CONV GALLERY & COLUMN A3 AT FLOOR EL 4461'
DETAIL 5/108 PIPING AT COLUMN A-3 CONV GALLERY
DETAIL 6/108 PIPING AT COLUMN A-1 CONV GALLERY
DETAIL 1/108 INLET SOUTH SIDE COLUMN C-4 AT FLOOR EL 4437'
DETAIL 2/108 HEADER & RISER WEST SIDE OF EAST CONVEYOR FLOOR EL 4437
UTAH COPPER DIVISION
MAGNA MILL
PRIMARY AND SECONDARY CRUSHING PLANTS
DUST COLLECTING SYSTEM
BENCH "A" — DETAILS
KENNECOTT COPPER CORPORATION
U50-09-102

U 50–09–102.

be inspected to make certain that the vital elements will show up clearly in the finished picture and not blend into other elements or the background. Care should be taken to level the camera so that column lines will be vertical and floor lines level. Any commercial continuous-tone film can be used for the pictures, provided it offers good definition with wide exposure and development latitudes.

The photographer-engineer should strive for reasonable uniformity of " flat " lighting. This is done with large diffused-light sources, which with a little experience can be used to obtain good detail without confusing shadow lines. Where it is not possible to arrange supplemental lighting or where lighting promotes too great a contrast or is uncontrollable the film should be slightly over-exposed and then under-developed about 25%. This will produce negatives which are sufficiently " flat " and still well detailed. A photocell light meter to gauge exposure setting and speeds is recommended, particularly if the pictures are to be taken by an inexperienced photographer.

Once the " field " pictures were taken a set of contact prints were run off from which preliminary layouts or " dummys " were made on standard 24 in. by 36 in. drawing sheets to determine which photographs would be used. After this 5 in. by 7 in. screened positive transparencies and a full-size positive copy of the standard blank drawing sheet (on auto-positive film) were ordered from a local photographic-reproduction company. Using the preliminary " dummy " as a guide the reproduction company's technician taped the 5 in. by 7 in. transparencies on the back of the autopositive drawing sheet and photographed the composite layout on to a polyester-base film having a matte surface on one side. The result was a full-size reproducible transparency on which the engineer added pencil draughting to complete the master photodrawing. Fig. 1 shows one of

**Table 1**

**Comparison of Engineering Costs**

| *Method* | *No. drawings* | *Man hours* | *Cost at $6/ man hour* | *Other costs* [1] | *Total cost* |
|---|---|---|---|---|---|
| | | | $ | $ | $ |
| *Chino Project.* | | | | | |
| Photodrawing | 6 | 144 | 864 | 211 | 1,075 |
| Conventional engineering with " as-built " drawings available | 7 | 420 | 2,520 | — | 2,520 |
| Conventional engineering without " as-built " drawings on hand | 7 | 560 | 3,360 | 360 | 3,720 |
| Savings, Photodrawing *v.* Conventional Engineering with " as-built " drawings | | | | | $1,455 |
| Savings, Photodrawing *v.* Conventional Engineering without " as-built " drawings | | | | | $2,645 |
| *Utah Project.* | | | | | |
| Photodrawing | 8 | 168 | 1,008 | 211 | 1,219 |
| Conventional, with " as-built " drawings | 9 | 450 | 2,700 | — | 2,700 |
| Conventional, without " as-built " drawings | 9 | 630 | 3,780 | 360 | 4,140 |
| Savings, Photodrawing *v.* Conventional Engineering with " as-built " drawings | | | | | $1,481 |
| Savings, Photodrawing *v.* Conventional Engineering without " as-built " drawings | | | | | $2,921 |

[1] Includes special materials for photodrawing method; field engineering at $6 per man hour for conventional method, without " as-built " drawings.

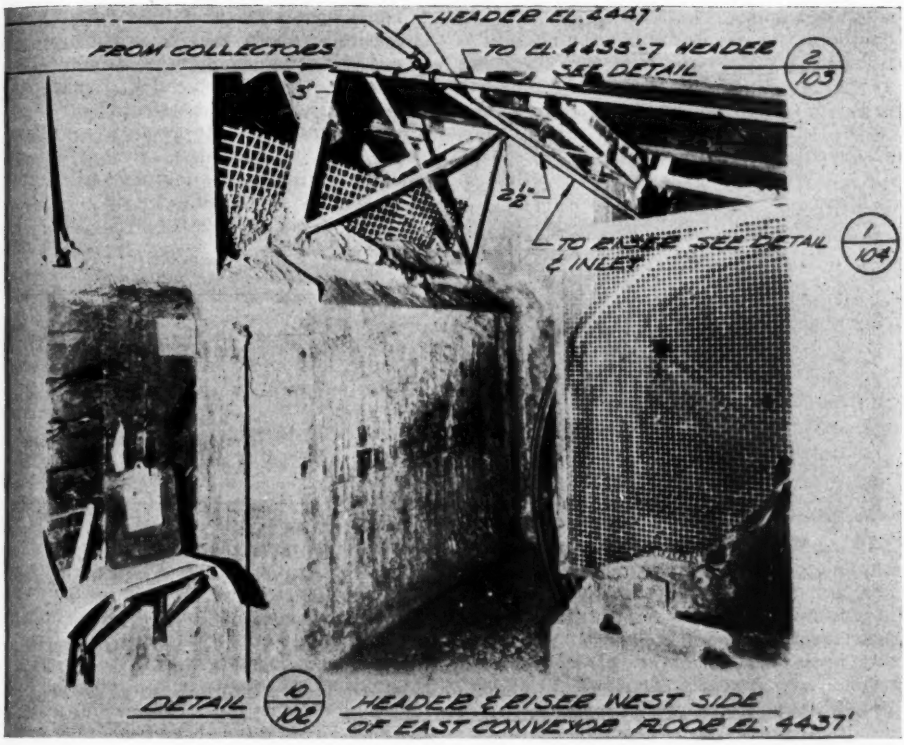



**Fig. 2.—Section Enlargement, with Added Line Work.**

the photodrawings produced for the Utah project and Fig. 2 is an enlargement of one section, detail (10/102), from this photodrawing, showing the line work added to complete the drawing.

The draughting work was performed over a light or " shadow " table using an " H " or " HB " pencil and normal draughting methods. To facilitate the draughting it may be necessary to tone down or obliterate portions of a photograph. This can be done directly on the master photodrawing, using mechanical erasing for toning down or for highlighting special sections of the pictures. For deleting areas on the photographs chemical eradicators can be used. As soon as the draughting is done the master photodrawing is ready to replace a conventional cloth or paper sheet for making direct-process prints.

Many advantages are realized with photodraughting. Erection or installation work can be expedited because photodrawings permit rapid identification of job requirements, particularly when workmen find it difficult to read conventional drawings, and the usual accompanying specifications, and therefrom visualize an intended end result. Errors can be minimized when they are caused by verbose instructions becoming confused or forgotten. Further savings can result from field crews not having to question their supervisors on details of construction and, when questions do arise, they can be resolved quickly and frequently without requiring the supervisor to take the time to visit the job site.

The most significant advantage, however, is the savings in time and cost that photo draughting can offer. In both projects described in this article an average of 24 engineering man-hours per drawing were all that were actually used, including time spent on the job taking photographs. On the Chino job five photodrawings and one isometric tracing were produced from 56 of the total of

60 photographs taken. On the Utah job six photodrawings, one isometric, and one electrical tracing were produced with 56 of the 61 photographs taken. The savings are shown in Table 1, which compares actual engineering costs for these jobs with the estimated costs of conventional engineering for the same work. Estimated costs are for the work both with and without " as-built " drawings.

The designers who worked on these jobs are enthusiastic about this draughting process and its potential for plant and maintenance engineering. Each successive project completed refines the methods used and results obtained and tends to produce additional savings. Photodraughting is a design method which should become a valuable tool for all plant-engineering offices.

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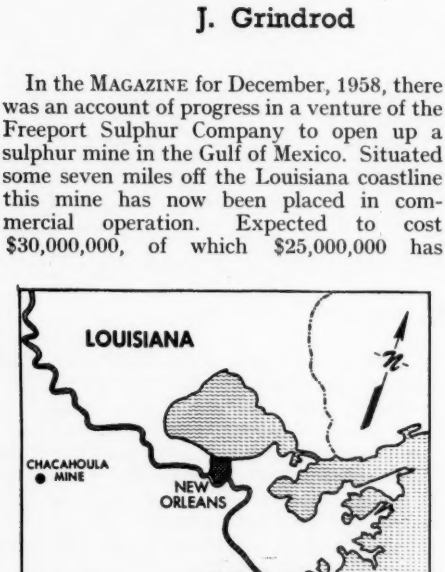
# An Off-Shore Sulphur Mine

A note on an American venture now in commercial operation

J. Grindrod

In the MAGAZINE for December, 1958, there was an account of progress in a venture of the Freeport Sulphur Company to open up a sulphur mine in the Gulf of Mexico. Situated some seven miles off the Louisiana coastline this mine has now been placed in commercial operation. Expected to cost $30,000,000, of which $25,000,000 has already been spent, the project involves the use of the largest permanent steel structure ever to be erected in the ocean. At present this is half a mile long, but it will eventually be extended as mining progresses to form a giant " Y " almost a mile in total length. Design work was begun in late 1956, the first structural contract was let in December, 1957, and off-shore erection began in June, 1958, taking 59 working days. Start-up operations began in mid-April, 1960, and some sulphur has already been produced and piped to the shore.




SULPHUR MINES IN LOUISIANA IN OPERATION OR UNDER DEVELOPMENT BY FREEPORT SULPHUR COMPANY

One of the largest of known sulphur deposits, the Grand Isle dome was discovered by the Humble Oil and Refining Co., the sulphur rights being assigned later by Humble to the Freeport Company, which agreed to construct and operate the mining facilities. Humble and Freeport will each receive, after taxes, approximately 50% of the net profits from the operation. During their oil prospecting in the area Humble Oil penetrated over 200 ft. of sulphur-bearing limestone between 1,813 ft. and 2,075 ft. and later drilled ten sulphur prospect holes, eight of which encountered sulphur ore, these exploratory holes being drilled on a square grid about 1,000 ft. apart.

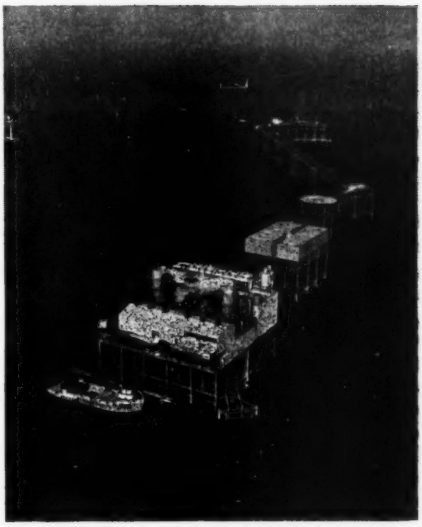
Most of the commercial Gulf Coast sulphur deposits occur in a caprock mantle of limestone covering the apex of an intrusive mass of salt, the limestone usually taking the form of a reservoir closed in by dense anhydrite on the bottom and impervious sediments above.

The Grand Isle occurrence follows this pattern to a considerable extent. The caprock overlying the sulphur horizon ranges in thickness from 0 ft. to 260 ft. and averages about 100 ft. It consists of permeable, porous to moderately dense, medium-grey limestone with white secondary calcite cementing small cracks and fissures. The underlying dark-grey anhydrite varies from 29 ft. to 190 ft. in thickness and has the sacharoidal texture often found in Gulf Coast salt domes. It is hard and dense, except when occasionally fractured, and is underlain by rock salt to an unknown depth.

The Grand Isle ore-body embraces several hundred acres and its outer limits are not yet defined to the N.E., E., and S. Well No. I–J, lying about 2,600 ft. N.E. from the nearest commercial well, penetrated 75 ft. of low-grade sulphur-bearing rock at 7,495 ft. and this curious occurrence is the deepest yet encountered in the Gulf Coast area. The depth of the ore-body ranges from 1,800 ft. to 2,500 ft. and, within its present boundary, the sulphur-bearing limestone varies in thickness from 220 ft. to 425 ft. and has a sulphur content of from 15% average in a lean hole to 30% average in a rich hole. Although the sulphur enrichment is not particularly high the thickness of the ore-body is a good deal greater than at other deposits in the Gulf Coast area.

Consisting of typical blue-grey to black, moderately hard, fine-grained fractured limestone, the gangue rock in the sulphur horizon varies from dense to vughy, porous, and highly permeable. This limestone has been recemented by white secondary calcite and sulphur. Lenses of marl and shale, as well as traces of gypsum, were struck in the drilling. Occurring in crystalline masses, in vughs, in disconnected veinlets, and as disseminations throughout the rock, the sulphur is expected to be discoloured, due to the traces of oil which are evident. Several cavities have been found, generally confined to the sulphur horizon, the largest being 18 ft. in depth.

In order to make the recovery of sulphur possible by the Frasch process the large steel structure at Grand Isle carries a complex of installations, the largest of which comprises the heating plant, shops, and warehouse unit. The heating plant consists of four boilers, *plus* mine-water preheaters, air-compressors, and turbo-generators and is designed to deliver an average of 5,000,000 gal. of 325° F. water a day, with a peak load exceeding 5,500,000 gal. a day. It is fuelled by gas from two near-by fields at a rate of 13,000,000 cu. ft. a day. Sea water, rather than the conventionally-used fresh water, is heated by a special patented process which was developed by Freeport in connexion with its small Bay Ste. Elaine mine, now exhausted.



**The Grand Isle "Island"**

At the opposite end of the steel island structure from the heating plant is the drilling production platform. Since subsidence at the first two production-platform locations is likely to occur as the sulphur is taken from the domes to an extent of about 25 ft., these platforms are not permanent. They will be salvaged and reconstructed at their original elevation after some 10 ft. to 15 ft. of settlement has occurred. The bridges of the structure are similarly to be jacked up and levelled when necessary.

So that the capacity of the heating plant can be used efficiently the wells into the sulphur dome must be drilled and equipped in advance of their actual need for production, since it cannot be predicted how long a well will be operated satisfactorily or how much sulphur it will produce. A number of wells are "steamed" simultaneously and, at Grand Isle, they are being drilled directionally from a multi-well platform, the well-heads being concentrated in a small area while the wells themselves, curving from the vertical, branch out, in inverted umbrella fashion, as far as 1,250 ft. horizontally from the surface location. Each well will have a true vertical depth of about 2,200 ft. and the maximum

angle of drive will be about 55° from the vertical, while the maximum build-up of drive angle will be 5° per 100 ft. of depth. During the past few years Freeport have brought directional drilling into routine practice at their Bay Ste. Elaine and Chacahoula sulphur mines and it is expected to prove economical at Grand Isle.

Each platform has 36 openings, from each of which three wells can be drilled, making it possible to drill and operate 108 wells from one drilling platform, although 12 is the maximum number that will be operated simultaneously. After a producing well has been depleted of sulphur the pipe will be salvaged and the bottom portion of the well will be plugged and abandoned. The same conductor pipe and surface casing will, however, be re-used and another hole will be side-tracked in a different direction. Bottom-hole spacing will be about 175 ft. Four platforms may eventually be required to provide complete coverage of the dome and each platform is expected to be rebuilt and relocated one or more times during the life of the mine.

Two decks are available on each platform, the lower having an elevation of 60 ft. above sea-level and the upper 75 ft. above sea-level. On the upper the drilling machinery and its auxiliaries take up about three-quarters of the space, while the rest is given over to a changing room for the crews, a tool house, a pipe threader, and pipe-storage racks. At the lower deck a centre bay contains the operating or producing well-heads and piping. The drilling-mud system, comprising pumps, shale shaker, desander, and mud pits, is along one side of the platform, while the relay or well-control station is also on the lower deck beneath the pipe reworking shop.

The drilling equipment being used is similar to that employed for light-duty oil-field work. A conventional 129 ft. high derrick on a 24-ft. base is mounted on a double substructure so that it, and its associated machinery, can be easily and quickly disposed at any location on the platform, one sub-base being movable longitudinally along the platform and the other being movable at right-angles to the platform's length.

Permanently mounted on the derrick floor is a 300-h.p. model F-30-D Ideco double-drum drawworks, capable of drilling to 5,000 ft. Since the pipe racks can be placed on either side of the derrick rather than opposite the driller's position the need for turning the derrick around as it draws near the end of the platform is avoided. The rotary table is at 95 ft. elevation above sea-level and the crown block is 223 ft. above sea-level.

Two mud pumps are provided and these consist of a 300-h.p., 8 in. by 14 in. unit, and a 150-h.p., 6 in. by 12 in. stand-by unit. The drilling mud from the well returns through permanently-installed troughs in the main derrick substructure and beneath the platform floor. Mud is stored in two tanks whose combined capacity is 750 barrels. Centrifugal pumps are used for mixing, transfer, supercharging, desanding, etc.

For handling the pipe and other materials between delivery barges and the platforms two 30-ton pedestal-mounted diesel-powered cranes are available. These will also be used for other jobs on the top deck—such as, changing airlines in producing wells.

A number of factors led to the decision to use electricity generated at the heating plant for driving all the drilling equipment and a.c. power is supplied through a 2,300-V line to the platform. Here it is converted to d.c. by motor-generator sets consisting of one 450-h.p., 2,300-V a.c. motor driving two 300-h.p. d.c. generators. All the d.c. generators and motors are interchangeable and the driller operates all the major pieces of equipment through a control panel mounted on the drawworks. The speed of the traction-type d.c. motors is controlled through variable excitation on the generator field.

The complete drilling programme has been laid out for the first platform, scale models being used to formulate the plan.

At Grand Isle the control station is located on the same platform as the well-heads, so that only short surface lines are necessary. Hot water to individual wells is piped through a header system down each side of the centre bay of the platform. Take-offs for each well incorporate water metering and control devices. Water-flow rates are adjusted in the control room by means of remote motor-operated valves and the volume is recorded by orifice meters. Sulphur from each well is individually piped along the side of the centre bay into one of two 40-ton collecting tanks.

About 5,000,000 gal. of hot water is pumped into the sulphur dome each day and a corresponding quantity of used cold water must be bled from the mine daily. Between eight and ten wells drilled directionally from a separate platform on a bottom-hole spacing

of 150 ft. to 200 ft. are needed to do this. Each bleed well is equipped with a Reda submersible electrically-driven pump capable of lifting 500 g.p.m. to 600 g.p.m. from a depth of 250 ft.

Providing a means of delivering the sulphur from the island to the shore was perhaps the greatest problem Freeport engineers had to face. Since transport was complicated by the weather at the exposed location the use of conventional barges and tugs would have been risky. The solution was found in burying a seven-mile-long heated pipeline in the bed of the Gulf and through this the 300° F. sulphur is pumped to the Grand Isle mainland base. Thence it flows into "thermos-bottle" barges and is towed 25 miles to Freeport's storage and shipping facilities at Port Sulphur on the Mississippi River.

The writer is indebted to the Freeport Sulphur Company and to a paper presented by C. O. Lee, Z. W. Bartlett, and R. H. Feierabend, of that company, to the Delta Section, A.I.M.E., New Orleans, Louisiana, for material from which this article has been prepared.

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# Operation of a Waelz Kiln

**A contribution to useful operational methods for the kiln**

**W. W. Krysko** [1]

The chief disadvantages of the Waelz kiln operation are the incrustations which form rings on the inside of the furnace. The author spent a considerable time in improving the working condition of the Waelz method for the volatilized roasting of antimony ore in Yugoslavia (Zajaca), where the internal diameter of the Waelz kiln was approximately 6 ft.

Incrustations usually started to grow on the third or fourth day of operation, the location of the growths depending on the draught, the composition of the charge, the percentage of reducing fuel added, and the temperature reached on the discharge side of the furnace. The author was unable to establish any statistical relationship of the influence of the above factors and the location of the incrustations, but the building up of a ring was followed usually by the formation of one or more balls on the charging side of the ring. In a few cases the balls had grown to about 3 ft. to 5 ft. in diameter. He cleaned the furnace in the following manner: The charging was discontinued, the rotation of the furnace was stopped, and the draught was increased to the maximum. Hardwood planks of large cross-sections were then placed in the kiln and the author entered the furnace in protective clothes and applied a strong water jet from a hose against the balls and the ring. The thermal shock embrittled the structure of the ring and the balls and after rotation was resumed the incrustations crumbled down in most cases.

In that way the average total time of interruption was cut down to 2 to 5 hours. It would be expected that the thermal shock could affect the refractory lining, but, during the nine months that the author applied this method, he could not note any detrimental effect. It could be said that the application of the water jet must be done most carefully to avoid the excess which could affect the refractory. On the other hand the water must be of sufficient quantity to produce a deep thermal shock on the incrustation.

A 1 in. internal-diameter heavy rubber hose with a brass nozzle was used, a regulating valve being installed between the hose and the nozzle with a large convenient operating handle. An inspection of samples of the incrustation showed a glass-like structure with inclusions of unburnt fuel and samples of unreacted ore.

When the incrustation started the slag showed a very sticky appearance and it could

[1] Dr. Krysko is Senior Lecturer, School of Metallurgy, The University of New South Wales, Kensington, Sydney.

be observed by binoculars that the slag which rolled down the wall enclosed parts which were not sticky in appearance. This unfortunately increased the growth of the incrustation considerably. A change in the heat supplied at the lower end of the kiln (powder coal), a decrease in draught, or a change of speed of rotation influenced the locality of the incrustations but did not help much.

Based on the above observation on the formation of the incrustation the author undertook the following experiment: When the incrustation ring reached a height of about 1 ft. some 20 to 25 wheelbarrows of dry quartz sand were charged instead of the usual charge. The majority of this sand has not taken part in any reaction with the charge when the sand reached the incrustations, but the sticky slag rolled in the sand and the balls and part of the ring was coated with sand. The sand-coated balls in front of the ring rolled and bounced against the ring without the usual sticky appearance and this on many occasions loosened the ring and forced it to collapse. At other times the ring bounced for half an hour in the kiln and moved slowly towards the cooler lower end. This method of introducing cheap, high-melting point, hard abrasive materials in one large charge avoids reaction with the sticky incrustation.

The author has on many occasions produced continuous furnace batches of 20 or more days.

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## Nickel in New Caledonia

Intended principally to feed new electric furnaces installed at the nickel smelter of Société Le Nickel at Doniambo, Nouméa, and to supply the township of Nouméa on the island of New Caledonia with electricity at the same time, a new hydro-electric project was completed on the River Yaté and placed in production by the Société Néocalédonienne d'Energie (Enercal) in 1959. Not only will the new generating station make possible an improvement in the quality of nickel produced at the smelter, but it will also cut production expenses and do away with the need for the costly importation of coke and gypsum.

Nickel, together with cobalt, chrome and iron ores make up most of the mining activities of New Caledonia, which has been French territory since 1853, and which is located at the antipodes, 1,300 miles from Australia. Nickel is one of the most important natural resources of the island and in 1959 some 1,378,000 metric tons of 3·2% ore was mined. Both demand and production are now again expanding following the world-wide recession in 1958 and the 1960 production is expected to reach the 1957 figure of 1,800,000 metric tons. Some of the nickel ore is exported and the rest is smelted on the island and then exported chiefly to France mostly as matte, containing 77% nickel and 23% sulphur. This processing has, however, in the past, proved very burdensome, partly because no valuable by-products are produced and partly because of the high cost of the raw materials such as coke and gypsum that had to be imported.

Originally the only metallurgical plant in New Caledonia had been established at Doniambo, Nouméa, by Société Le Nickel, but about 1925 a small electro-metallurgical plant was placed in operation at Yaté on the south-east coast which was fed by a 15,000-kW hydro-electric station on the River Yaté. This plant was, however, tightly packed between the steep slopes of the bay at Yaté, which was accessible only from the sea by small draught barges or lighters.

In 1949 the furnaces at Yaté were closed down and the current diverted by a 90,000-V transmission line to Nouméa, where it was used to feed two new furnaces installed at the Doniambo plant. Soon, however, this low-powered plant, fed by the "run of river" type of power station at Yaté, proved inadequate to meet the needs of the fast expanding nickel industry, particularly for the Japanese market, and the company decided to remodel completely its facilities and to install at Doniambo modern electric furnaces for the production essentially of ferronickel as well as pure nickel. This was made possible by the construction of a new generating station on the Yaté River by Société Néocalédonienne d'Energie, a company of mixed economy, created for the purpose. This new power station is installed with four 17,000-kW vertical Francis turbines rated at 21,800 h.p. and four three-phase alternators. The output is stepped up from 8·66 kV to 150 kV and delivered to the electric furnaces at Nouméa by an entirely new 55-km. transmission line.

# Notes on Strontium

**M. Schofield,** M.A., B.Sc., F.R.I.C.

**A brief review of recent developments in strontium technology**

One of the most remarkable chapters in British mining history concerns the manner in which a limited area in Gloucestershire has provided major strontium supplies for many years. The element in other respects is closely linked with barium, for both these alkali metals were first liberated by Humphry Davy 150 years ago and both are found as sulphate and carbonate, with similar applications in industry, just as their chemistry is so alike. Yet, while barium production as barytes has risen to almost 2,000,000 tons per annum, strontium as celestite is so much a British concern that of a world production of 15,000 tons maximum in 1956 most of this came from the Triassic marls near Yate, Gloucestershire, and from border deposits in Somerset.

As regards the carbonate minerals of barium and strontium, here there is some resemblance. For while chemical industries would prefer the acid-soluble carbonates for working up to strontium and barium salts, deposits of these are rarer apart from some relatively thin veins in Westphalia and some Spanish strontianite. Barium carbonate, named *witherite* after Dr. Withering of Birmingham, who discovered the mineral in his geological researches, is only mined economically from the Holmside and Settlingstone coal mines in Durham. Both strontium and barium derivatives thus come mainly from the insoluble sulphates which are worked up in similar processes.

As with witherite, the carbonate of strontium took on a British name from first developments. Strontianite was found in a lead mine at Strontian, Argyllshire, so that strontium became the sole element " to flaunt in its name the glorious circumstance of a Scottish origin " as an enthusiast put it. It was as long ago as 1790 that Dr. Adair Crawford published an account of an earth present in " a mineral sold at Strontian, Scotland " which differed from *terra ponderosa* or barytes, with which it was confused. Crawford failed to note the prominent crimson flame coloration; hence it was left to Hope of Edinburgh to study fully Strontian Spar and note the red colour given to a candle flame.

Davy isolated calcium, barium, and strontium as tiny beads of metal by a rough electrolytic experiment in which the metals were recovered from an amalgam by distilling off the mercury. Yet it may be mentioned at this point that strontium metal has found little application in industry. A product of 99·6% purity prepared by the Thermit process may be purified to high-grade strontium metal by distillation at 1,000° C. or the metal may be produced by electrolysis, as with calcium. Such extraction processes are used on but a small scale, however, since strontium metal is only occasionally used as deoxidizer for copper and bronzes, as tin or lead alloys with 5% strontium, and for imparting hardness to lead used for storage batteries. Barium has similarly found very moderate uses in bearing metals, Germany producing new lead-base alloys during the war for big-end bearings in diesel engines; yet here again the metal in industry is insignificant compared with the wide use of compounds.

It can easily be appreciated why strontium should be regarded as a relatively " rare " element. For many years the Yate deposits of celestite have been the sole economic source in the world, with other potential sources found in Canada, Tunisia, and the U.S.S.R. only in recent times. About 160 years ago came the first hint, when Thomas Beddoes referred to several veins of " Strontites " found in the neighbourhood of Bristol and confused with barium sulphate. Before the first world war Gloucester celestite came into commerce as a result of German interests seeking strontium minerals for converting to the hydroxide used in the Scheibler process for sugar extraction. As many as 12 German refineries were using this process, in which strontium saccharate is an intermediate in winning sugar from molasses, a process which was to become obsolete yet which sponsored the industrial uses of strontium. During this

first period, in which superior Yate celestite more than competed with Westphalian strontianite, the Gloucestershire mining of it was a rough technique. Spar digging was often a spare-time job by farmers, with mainly outcrops dug and deeper deposits left. Though celestite in clays, sandstones, and limestones is not so workable as strontianite, yet it is preferred, since strontianite so often includes appreciable calcium carbonate.

Simple quarrying went on in the West Country for some years, for the shallow deposits were but 2 ft. or little more below the surface, the celestite being hand-cobbed and stacked by the roadside to await transport by lorry. Sounding by long rods was introduced, while later came more modern quarrying, using bull-dozers and mechanical methods, top-soil having to be replaced so as not to affect farming too seriously.

The Gloucester-Somerset deposits were explored by the Bristol Mineral and Land Company, while other interests also came into strontium proving, the British Quarrying Company, for example, taking strontium along with the main target, which was quartzite. Pockets became exhausted yet others were found, but in recent years celestite workings have been mainly confined to an 1,800-ft. wide strip running seven miles southwards from Yate.

Celestite is prepared for the market using primary jaw-crushers, this being followed by cleansing and drying in rotary oil-fired plant. Secondary jaw-crushers are then used, the product being powdered and air-separated in Raymond-type plant, a 300-mesh celestite being a common type for packing in paper bags. The strontium sulphate in converting to the soluble strontium salts for industry requires similar treatment to that given to barytes. The sulphate is reduced to sulphide by roasting with coal or other carbon, the sulphide being dissolved in nitric acid and the carbonate precipitated.

An alternative route to the carbonate is the prolonged boiling of celestite with sodium carbonate.

Strontium sulphate is used as " strontium white " in the paint industry, in rubber compounding, and as a filler for gramophone records and asphalts, the powdered celestite for this being usually 92% $SrSO_4$ with calcium and barium sulphates as impurities. When barytes is used as extender or pigment in the paint industry, bleaching with dilute sulphuric acid is successful when staining is only on the surface or on cleavage planes. In the case of celestite this bleaching by acid is even more troublesome. Off-colour celestite, like similar grades of barytes, find general uses as fillers, while yet another comparison in application of the sulphate is seen in oil-well drilling. Up to 1943 barytes as weighting agent in well-drilling was protected by patent, but when the patent expired the alternative use of strontium sulphate declined. On the other hand some celestite deposits have proved suitable for this application when regarded as uneconomic for strontium chemicals, an example being the celestite in the Brown and Nolan counties in Texas.

Apart from the sulphate there is a number of strontium compounds now used in industry to compensate for the disappearance of the major outlet in the Scheibler process for beet-sugar, and for the decline in use of strontianite for reducing phosphorus and sulphur in the basic process for high-grade steels. For some years the most important strontium salt has been the nitrate used on a large scale for giving a vivid red colour to flares for railway safety signals, distress signals, landing flares for aircraft, and to tracer bullets and red stars for military operations, as well as in pyrotechny. The first world war saw celestite and strontianite worked in the United States, with production ceasing afterwards until 1940, when war demands for flares caused more importing of celestite from Britain. Further production in Texas, California, and Mexico stressed the military importance of strontium compounds including the peroxide and chloride as well as the nitrate. From 7,000 tons mined during 1943 the total from such American sources dropped to almost zero by 1947. Yet with strontium reserve sources thus developed some peace-time applications were found for Texas and Californian strontium, one example being the purification of caustic soda in which iron and manganese impurities are precipitated. Most of the demands for strontium apart from the natural sulphate require a higher purity and better grade celestite as raw material for producing strontium chemicals. Thus while the United States was producing appreciable strontium of " chemical grade " celestite came from open-cast mining at Westmoreland, Imperial County, California.

A variety of other applications have been proposed and at times adopted for strontium compounds apart from those given above.

The carbonate has been used in enamels and frits in place of lead, the oxide in conjunction with vanadium oxide for special glasses, and the titanate for artificial gems and other articles. The carbonate is specified for including in spark-plug insulators for resisting leaded petrol and for increasing the life of tungsten cathodes. The titanate has proved useful in modifying the properties of ceramic dielectrics from barium titanate; the fluoride and phosphate in optical glasses, while strontium sulphide is a regular constituent of luminous or luminescent materials. One established use is for the chromate as a rust-inhibiting pigment and also as pigment in a one-pack etch primer. In 1947 came the first strontium greases for resisting water and hydrocarbons, the hydroxide and stearate being used. Such greases are lubricants noted for withstanding higher temperatures than calcium soaps and are claimed to be particularly resistant to oxidation. Finally there are applications for the purest of strontium compounds on the market—for the sulphide as depilatory in cosmetics, for the salicylate, bromide, chloride, and iodide in medicine and pharmacy.

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# Variable-Speed A.C. Motors[1]

J. L. Watts, A.M.I.E.E.

The author reviews the design and control system of special Motors

*Speed Control.*—A somewhat similar principle is used in the more common arrangements of stator-fed commutator motors, in which the speed regulation is effected by means of an induction regulator, as in Fig. 4. The primary windings (*P*) of the induction regulator are often fitted on its rotor, with its secondary windings (*S*) on its stator. The induction regulator acts as a transformer of variable ratio, the output voltage of which is capable of infinite variation, within its range, by turning its rotor through part of a revolution.

In its mid position the secondary voltage of the induction regulator is zero and the motor then runs as an induction motor with its rotor windings short circuited through the secondary windings of the regulator. The characteristics of the motor are then similar to those of a slip-ring motor with short-circuited rotor, the motor running at a few per cent. less than its synchronous speed on full load. When the regulator is turned in one direction from this position it injects into the motor rotor windings a voltage which opposes that induced in the windings by the revolving magnetic flux, thus reducing the rotor current and torque to reduce the motor speed.

If the regulator is turned in the other direction from its mid position the injected voltage from the regulator assists the induced rotor voltage of the motor, thus increasing the rotor current and torque, which causes the motor to accelerate. The induced rotor (secondary) voltage falls to zero as the motor reaches its synchronous speed and then rises in the opposite direction as the slip becomes negative above synchronous speed. This is indicated in Fig. 3. Above synchronous speed, therefore, the induced rotor e.m.f. opposes the injected voltage so that the rotor current and torque fall, acceleration ceasing when its torque has fallen to the same value as the resistance torque of the coupled load.

*Power Factor and Power Flow.*—Auxiliary windings are frequently fitted on the stator of the motor, as in Fig. 4, to improve the power factor. Such motors have a constant full-load torque, with full-load horse power proportional to the speed. The induction regulator enables infinite variation of speed to be obtained over the full speed range. A common ratio of maximum to minimum speed is three-to-one, but much higher ratios

[1] *Concluded from the August issue, p. 94.*

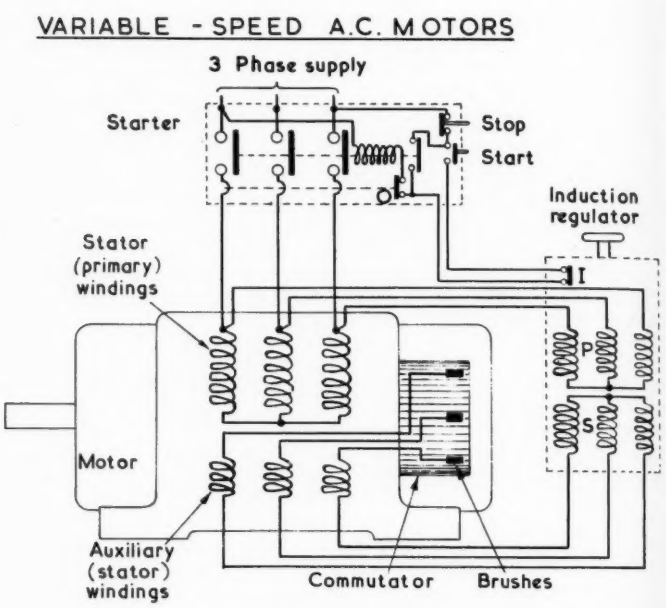


**Fig. 4.—Connexions of a Stator-Fed A.C. Motor.**

are obtainable from these types of motors, when suitably designed. These motors have a high efficiency and power factor. When run at less than synchronous speed some of the power taken from the mains by the stator windings of the motor is returned to the mains *via* the induction regulator. When run at more than synchronous speed power is fed direct from the mains to the stator windings of the motor and is also fed from the mains to the rotor windings of the motor through the regulator. Since the injected voltage is independent of the load the fall of motor speed from no load to full load is usually no more than 10% of the maximum speed. Stator-fed polyphase commutator motors are obtainable in sizes up to about 1,000 h.p.

### N.–S. Commutator Motor

Fig. 5 shows one arrangement of the N.–S. stator-fed three-phase commutator motor. This utilizes a double-induction regulator, consisting of two single-induction regulators with the two rotors on one shaft. An auxiliary winding is fitted on the motor stator to improve the torque characteristics and power factor. In some cases a special compensating transformer is fitted in the induction regulator instead of in the motor.

*Commutation.*—As the rotor of an a.c. commutator motor revolves its rotor (secondary) coils are short-circuited in turn by the commutator brushes and special steps are taken to limit the current in the rotor coils during commutation in order to avoid sparking at the brushes. High-resistance brushes and high-resistance connexions between the rotor coils and commutator have been adopted in some cases. In the N.–S. variable-speed motor auxiliary windings are fitted in the rotor slots, these being so connected that e.m.f. induced in these windings compensates for the commutating e.m.f. in the rotor coils with which they are connected in parallel. Speed ranges up to about 17 to 1 are available. Fig. 6 shows the speed/torque characteristics of one such motor having a speed range of three to one. Stator-fed commutator motors are available with various types of enclosure and for use on medium or high voltage. They can be arranged for dynamic braking by d.c. injection if required and can be designed for reversing duty.

Stator-fed a.c. commutator motors may also be obtained which have a series characteristic, the primary windings of the induction regulator then being connected in series with the stator (primary) windings on the motor so that the injected voltage varies with the load on the motor. Fig. 7 gives the

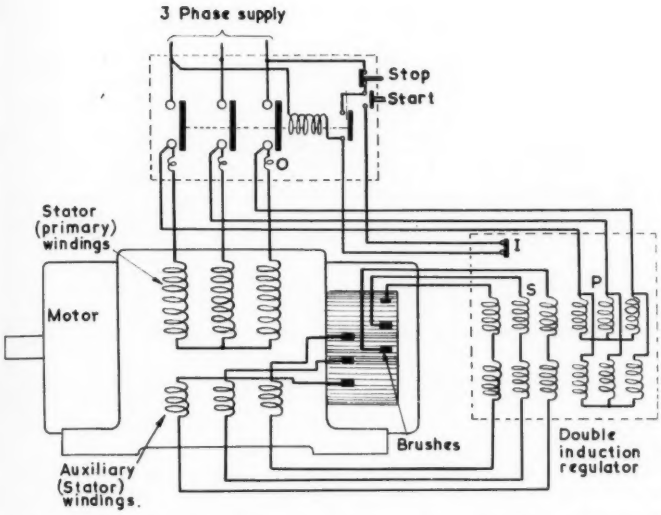


**Fig. 5.— Connexions of a Stator-Fed N.–S. Motor.**

speed/torque characteristics of one such motor at various positions of the induction regulator.

### Schrage Motor

Another variable-speed a.c. commutator motor which, however, has no external regulator, is the Schrage motor. The primary windings of this motor are fitted in slots in the rotor and are fed from the supply through slip rings and brushes, as in Fig. 8. In the rotor slots also is a separate auxiliary winding for speed regulation, this being similar to that of a d.c. armature and being connected to a commutator. The secondary windings of this motor are fitted on the stator. The commutator brush gear is mounted on two rockers, each having a toothed rack and carrying three brush spindles per pair of poles. Pinions mesh with the toothed racks so that the two rockers can be turned in either direction by means of a handwheel or a pilot motor. Since the brushes on the two rockers ride on different tracks on the



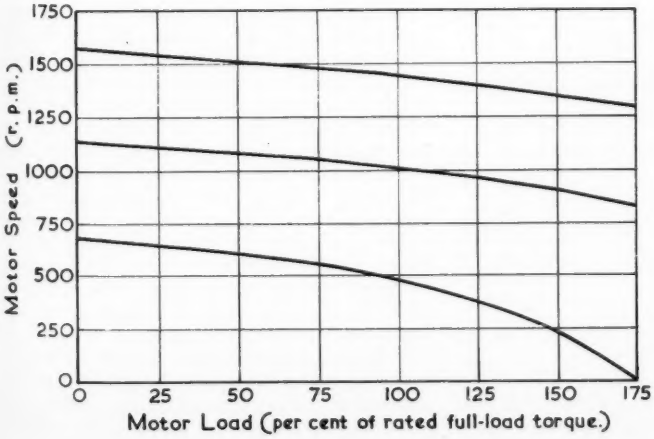


**Fig. 6.— Speed-Torque Characteristics of a N.–S. Motor.**

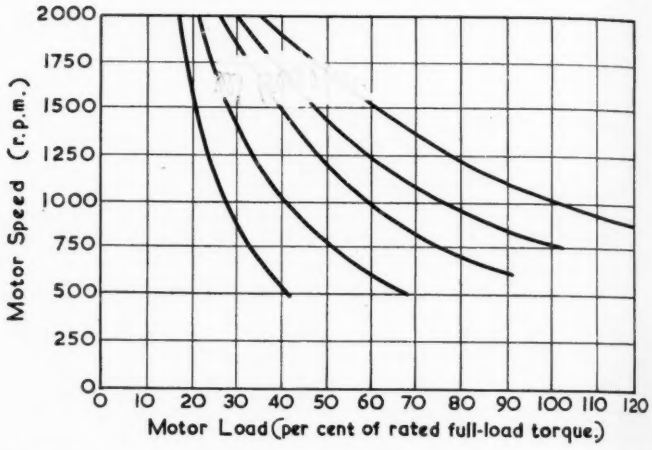


**Fig. 7.—Speed-Torque Characteristics for a Stator-Fed A.C. Commutator Motor.**

commutator the brushes X and $X_1$ connected to one section of the stator windings can be separated in either direction or short circuited on one segment, as indicated in Fig. 9.

*Operation.*—The supply current through the primary (rotor) winding creates a magnetic flux which revolves round the rotor core at its synchronous speed. When the stator windings are short circuited through the commutator and brushes, as in Fig. 9*b*, the machine acts as an inverted induction motor. The induced secondary (stator) current then reacts with the revolving magnetic flux of the rotor to create the torque which turns the rotor round in the opposite direction to its own revolving magnetic field. The induced secondary (stator) current has slip frequency *Sf* and the motor runs at slightly less than its synchronous speed.

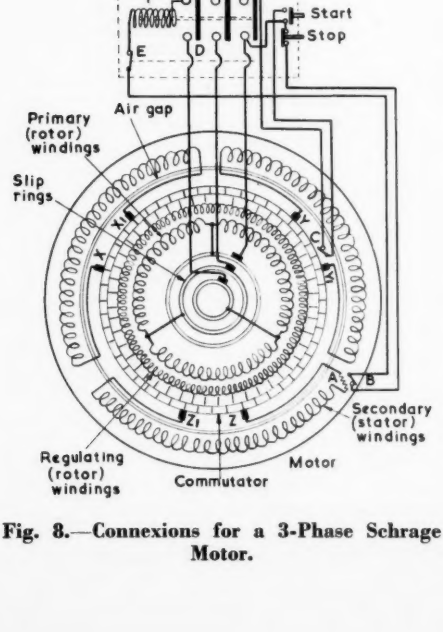


**Fig. 8.—Connexions for a 3-Phase Schrage Motor.**

The revolving flux cuts the regulating windings at synchronous speed, whatever the motor speed ; the primary and regulating windings thus act as a transformer and e.m.f.s of supply frequency *f* are produced between the commutator segments. The e.m.f.s induced in the regulating windings under the influence of magnetic poles of opposite polarity act in opposition. Thus with the brush position shown in Fig. 9*b*, when there is no external circuit between the commutator segments, no current flows in the regulating windings. When the brushes are separated there will be voltage of slip frequency between them, the commutator and brushes acting as a frequency converter. This voltage thus has the same frequency as that induced in the stator (secondary) winding by the revolving flux and can, therefore, be injected into the stator windings to control the secondary (stator) current.

With the brushes separated in one direction, as in Fig. 9*a*, the injected voltage opposes the induced secondary e.m.f. and the motor runs at less than synchronous speed. If the brushes

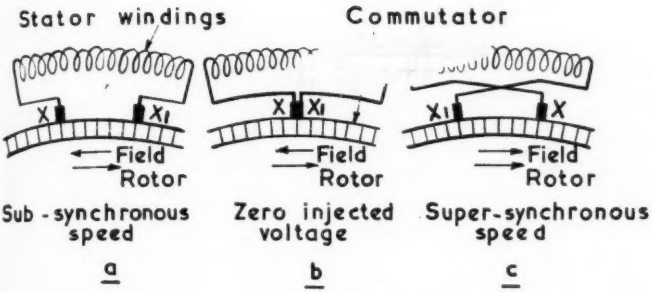


**Fig. 9.—Flux and Rotation in a Schrage Motor.**

are separated slightly in the opposite direction the injected voltage assists the induced secondary (stator) e.m.f. to increase the secondary current and motor torque. In this way the motor can be run at its synchronous speed if required. At synchronous speed the a.c. voltage of supply frequency in the regulating windings is converted to d.c. at the commutator brushes; the magnetic field of the rotor then becomes stationary, since it then revolves at synchronous speed round the rotor in the opposite direction to the rotor. Further separation of the brushes, as in Fig. 9*c*, causes the motor to accelerate above synchronous speed. The flux then revolves round the stator in the opposite direction, reversing the induced stator e.m.f. so that this then opposes the injected voltage. The stator current and motor torque then fall as the speed rises, the speed reaching a steady value when the motor torque has fallen to the same value as the load resistance torque.

*Characteristics.*—Thus the Schrage motor can be operated economically at various speeds above or below synchronous speed. The power factor and starting torque can be controlled by shifting the whole set of brushes round the commutator to vary the phase of the injected voltage. The brushes of a reversing motor are usually set co-incident with the neutral position. However the brush rockers of a non-reversing motor may be meshed with pinions having different numbers of teeth, so that as the brushes are separated they are also shifted round the commutator. This gives the motor a high power factor and a high starting torque with minimum fall of speed on all loads, the fall of speed from no load to full load being $2\frac{1}{2}\%$ to 10% of the maximum speed. Fig. 10 shows the power factor and efficiency of a large Schrage motor with different brush positions.

A small Schrage motor may be started with the brushes set for any speed, but a larger motor usually has an interlock switch, as shown at C in Fig. 8, to ensure that the brushes are set for minimum speed at starting. When set for minimum speed a standard motor may exert about 150% of its full-load torque at starting, with about 175% of full-load current. Motors are available from one to several hundred horse power, with speed ranges from 2 to 1 to 15 to 1, depending on the design and horse power. The motor can be arranged for reversing duty; it can also be "plugged" or arranged for regenerative braking.

*Protection.*—The full-load torque of a normal motor is constant, the full-load horse power being proportional to the speed, although motors can be designed to have other characteristics. When running on reduced speed the stator (secondary) windings may be fully loaded, whilst less than

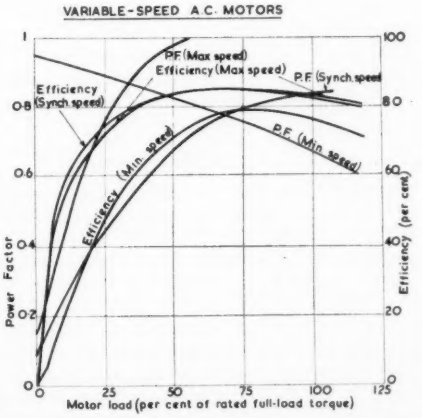


**Fig. 10.—Power Factor and Efficiency Curves.**

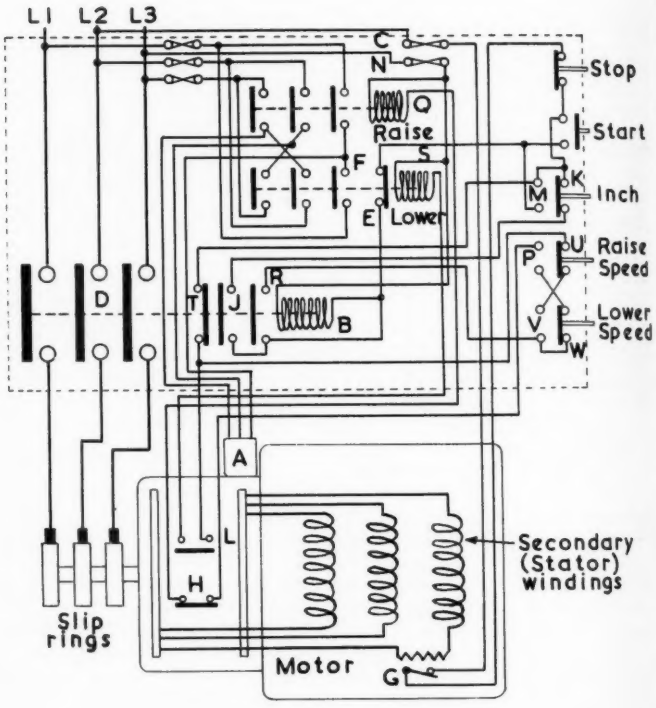


**Fig. 11.—Connexions for an Automatic Starter.**

full-load current passes through the rotor (primary) windings. In order to protect the secondary windings against overload on reduced speed, therefore, an excess-current element, as at A in Fig. 8, may be connected in the secondary circuit to control contacts B in circuit with the breaker coil F. The line-connected excess-current elements D are also required to protect the motor against overload at high speeds, short circuits, or earth faults in the windings.

### Remote and Automatic Control

Variable-speed a.c. commutator motors can easily be arranged for remote control by means of a pilot motor which operates the induction regulator of a stator-fed motor or the brushgear of a Schrage motor. The pilot motor may be energized by push-button switches or by auxiliary switchgear operated by change of some physical condition such as pressure, liquid level, weight, etc.

Fig. 11 shows the connexions for controlling the speed of a Schrage motor by push-button switches. When the start push button is pressed, with the contacts *L* on the brushgear open to de-energize *S*, current flows from $L_2$ through the fuse *C*, over-load contacts *G*, stop and start push-button switches, contacts *E*, coil *B* and the fuse *N* to $L_3$. The coil *B* then closes the contactor *D* to start the motor; the contacts *J* then closing to keep the coil *B* energized through the "inch" push-button switch contacts *K* when the start push button is released. If the "inch" push-button switch is used instead of the start button the contacts *K* are opened to prevent the retaining contacts *J* being operative, the motor then turning at its minimum speed only while the inch-button contacts *M* are held closed.

If it is required to raise the motor speed after starting the "raise speed" button is pressed to close the contacts *P*. The coil *Q* is then energized from $L_2$ and $L_3$ *via C*, *G*, the stop-button contacts, *K*, *J*, *R*, *W*, *P*, *H*, and *N*. The coil *Q* then closes the "raise" contactor to energize the pilot motor *A* to shift the commutator brushes for increased speed. If the "raise speed" push button is

not previously released the pilot motor will be switched off when the brushes reach the maximum-speed position, since the contacts $H$ will then open to de-energise $Q$. Similarly the speed can then be lowered by pressing the "lower-speed" button to energize the coil $S$ from $L_2$ and $L_3$ *via* $C$, $G$, the stop-button contacts, $K$, $J$, $R$, $V$, $U$, $L$, and $N$, the contacts $L$ being open only in the "low-speed" brush position.

When the stop button is pressed the coil $B$ is de-energized to switch the current off the slip rings. If the brushes are not then in the "slow-speed" position the contacts $L$ will be closed and the contacts $T$ will close as the main contactor $D$ opens. As soon as the stop button is released the coil $S$ will then be energized from $L_2$ and $L_3$ *via* $C$, $G$, the stop-button contacts, $T$, $L$, and $N$. The coil $S$ will then close the contacts $F$ to cause the pilot motor to return the brushes to the starting (slow-speed) position, when the contacts $L$ will open to de-energize $S$.

Auxiliary gear can also be obtained which will maintain the speed of an a.c. commutator motor at a constant value on varying load or voltage, or will vary the speed in accordance with a reference voltage, to a high degree of accuracy—say, within *plus* or *minus* 2 r.p.m. These motors can also be provided with control gear which will accelerate them up to a pre-set speed after pressing the starting button or the closing of an auxiliary switch.

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# The International Geological Congress

Some notes on the conferences in Copenhagen

### Introduction

The twenty-first session of the International Geological Congress held in Copenhagen from August 16 to August 25 was the occasion of the greatest concourse of geologists ever seen. A record enrolment of around 3,500 attending and 900 non-attending members much surpassed all previous figures, which at the last Congress in Mexico City four years ago had risen to 2,120 members in attendance, with a further 1,576 not attending. That the discussions of this immense assembly proceeded without any noteworthy hitch reflects the greatest credit on the organisers in Denmark, Sweden, Finland, Norway and Iceland, who were responsible not only for the meetings in Copenhagen but also for an elaborate series of field excursions both before and after the formal presentation of papers. There have been few such international meetings, in any field of human endeavour, which have reached a comparable level of success.

The Congress was divided into 22 main sections, covering a great many topics of current interest in geological science, at which there were presented more than 400 papers, all printed before the meetings and presented to members in 22 volumes of Proceedings totalling 4,163 pages. In addition there were meetings of some 15 Commissions established by the Congress, and at least eight affiliated scientific societies took the opportunity of holding discussions within their fields of specialization, sometimes lasting several days. It is manifestly impossible for a single reporter to review all these activities in a brief article, and this account must therefore be restricted to a bare mention of some of the items of interest to mining men.

Noteworthy in this category were the contributions on Genetic Problems of Ores (24 papers), Genetic Problems of Uranium and Thorium Deposits (14), Regional and Structural Problems in Oil Geology (11), Geological Results of Applied Geochemistry and Geophysics (21), Minerals and Genesis of Pegmatites (13), and Engineering Geology with Hydrology (8). In each group the published papers had an average length of ten pages. The Association of African Geological Surveys held a two-day symposium on the geology of the African copper deposits; the Geochemical Society sponsored discussions on the geochemistry of sedimentary

carbonate rocks; and Commissions of the Congress reported on International Metallogenetic and Tectonic Maps, and on progress towards the establishment of an international Abstracting Service

The principal official language of the Conference was English, and three-quarters of the contributions were presented in that tongue. Only a small proportion of the papers from the U.S.S.R. were however received in time for publication in English translation. The full text of the 398 works from the Soviet Union (which make no contribution to the symposium on uranium and thorium ores) has been published independently in 22 Russian volumes, available from the publishers (Gosgeoltekhizdat) at a nominal price up to January 1, 1961.

### International Union of Geology

Among the administrative business of the Congress, perhaps the most important and far-reaching item was a proposal from the British National Committee for Geology, that there should be established an International Union of Geology, affiliated to the International Council of Scientific Unions, to provide a permanent standing body able to deal promptly with international geological matters whenever they may arise and to facilitate a greater measure of contribution by geologists to international projects involving co-operation among scientists. It was claimed that since all sciences save geology have international unions within the framework of I.C.S.U., the status of geology as a science was being impaired. For example, geology was not formally represented on the committee for the International Geophysical Year.

Following prolonged discussions, at which opinions were divided, the Bureau and Council of the Congress eventually approved a proposal to found such an International Union of Geology, whose aims would be: (1) To promote and encourage the study of geological problems; (2) to facilitate international co-operation in geology and related sciences; (3) to provide continuity in international co-operation in geology; and (4) to assist the International Geological Congresses, it being understood that the long-established activities of the Congresses shall be safeguarded.

### Geological Abstracts

The Commission for an International Geological Abstracting Service announced completion of arrangements for publication of *Geological Abstracts*, which will attempt to provide a comprehensive summary of all published work in every field of pure and applied geology. The annual service will comprise six subject volumes and an index, to be produced by non-letterpress and photo-lithography, each volume being issued in approximately monthly parts. There will be a subject break-down into (a) mineralogy with igneous and metamorphic petrology; (b) palaeontology; (c) geomorphology and sedimentary petrology; (d) stratigraphy and general geology; (e) structural geology and geophysics; (f) economic and applied geology. It is claimed that the scrutiny of all standard geological journals will be undertaken on a world-wide basis and that particular attention will be paid to the inclusion of current work from Russia, China and Eastern Europe. Since however the latter publications are well covered by the Russian journal of abstracts *Referativnyi Zhurnal—Seriya Geologiya*, presumably they will be dealt with mainly by translation of selected Russian abstracts.

*Geological Abstracts* is to be published on behalf of the Commission by Pergamon Press. The annual subscription is announced at £70, with a reduced rate of £35 for educational institutions, libraries of geological societies, and public libraries, and a further reduced rate of £7 to individual members of geological and other learned societies, for personal use. The magnitude of the effort required to provide a good coverage of geological literature may be deduced from the fact that the Russian journal (£17 per year) employs over 400 abstractors. Unfortunately the specimen abstracts submitted as a sample of the content of the forthcoming journal fall some way below current standards in their brevity, their anonymity, and (for foreign-language papers) the absence of titles save in English translation.

### Problems of Geochemistry

The sessions of the Congress dealing with pure and applied geochemistry were enlivened by much discussion, and they embraced not only papers presented in the Proceedings but also a joint symposium of the International Geochemical Society and the Geochemical Commission of the International Union of Pure and Applied Chemistry. The latter contributions, principally on the availability of standard samples for chemical analysts and on the geochemistry of carbonate rocks,

will be published in *Geochemica et Cosmochimica Acta*.

Of the reports of direct economic interest mention may be made of studies on the distribution of trace elements in organic soil and peat as a guide to copper ore underlying peat deposits in North America; and of geochemical prospecting work for mercury in Yugoslavia, for copper, lead, and zinc in the glaciated areas of eastern Canada, for copper in Northern Rhodesia, and (by biochemical methods) for iron and alumina in Yugoslavia. The importance of geochemical and geophysical studies in the disposal to ground of low-level radioactive waste was stressed in an official American contribution.

The geochronologists, considering a host of new age determinations for the fossiliferous systems and for pre-Cambrian rocks, found themselves in general agreement about the need to lengthen the geological time scale, with the lowermost Cambrian now dated at about 600 million years. Russian workers, in a study of the old rocks of the Baltic Shield based on more than 500 datings mainly by the K—A method, demonstrated the existence of ten age groups in the pre-Cambrian, each consisting of schists and and gneisses with granite pegmatites, ranging upwards from the Lower Katarchaean at 3,500 million years. A somewhat similar sequence, beginning with rocks more than 3,000 million years old, was distinguished for Ukraine.

**Genetic Problems of Ore Deposits**

Of the contributions to the sections concerned with the genesis of ore bodies, 17 were concerned with uranium ores, nine with polymetallic sulphide deposits, nine with general topics of ore genesis, three with iron ores, and two with bauxites.

The papers on uranium ores included an official presentation from South Africa on the genetic problems of uraninite in the South African bankets, in which the evidence for a placer or at least syngenetic origin of the mineralization was clearly expounded. On the other hand an American paper stressed the importance of hypogene solutions as a source of uranium ores; but this departed from orthodoxy in an attempt to demonstrate that these hypogene solutions may start escaping from magmas long before the formation of granite and may evolve intermittently until the end of fractional crystallization. It was maintained here that there was evidence for the escape of uraniferous solutions from magma at roughly the same time as diabase and lamprophyre dykes were intruded.

Many other reports were concerned with the redistribution of uranium by both oxidizing and reducing ground-waters, the latter being charged with mobile hydrogen sulphide produced either as a by-product of maturation of petroleum or by sulphate-reducing bacteria. An interesting occurrence of uranium enrichment in peat was described from northern Sweden; and another noteworthy work from France presented a detailed radiogeological—geochemical study of a granite in the Vendée, establishing statistically the variation trend of uranium in relation to the other chemical elements of the rock. An epigenetic uranium mineralization from South Sweden consists of thucholite, uraninite, davidite and other radioactive minerals in non-granitized pre-Cambrian quartzites and in transgressive pegmatites and aplites.

Conflict between syngeneticists and epigeneticists was also apparent at other sessions. Reviewing the evidence concerning the origin of the Mt. Isa ore bodies, the geologists of the Australian Bureau of Mineral Resources found strong support for the syngenetic hypothesis in the lack of feeder channels, the fine-grained bedded nature of the ore with thin individual beds persisting for thousands of feet, association of ore with slump rolls and slump breccias, and the lack of metasomatic alteration of the country rock. In favour of hydrothermal origin are the typically mesothermal assemblages, the presence of exsolution laths of chalcopyrite in sphalerite, and the apparent localization of mineralization by structure. It was concluded somewhat incongruously that the evidence favoured syngenesis for the lead-zinc ores, but that the associated copper ores might be epigenetic.

A Swedish paper on the the lead deposits of northern Sweden took a different viewpoint. These ores are developed as extensive disseminations of galena and sphalerite in quartzitic sandstones of Eo-Cambrian and Cambrian age, the mineralization (galena, sphalerite, pyrite, calcite, barytes, fluorspar and sericite) being found especially where quartzite lies between impounding beds of shale or shaly sandstone and being controlled by tectonic features such as faults, fissures and crush zones. It is considered that the ores were deposited hydrothermally, originating from palingenic zones in the local Caledonides. The Laisvall mine in Lapland

produces about 700,000 tons of lead a year, and from 1960 Vassbo in northern Dalecarlia will produce 150,000 tons a year.

From Finland came a paper on the possible genetic origin between sulphide schists and ores, postulating that the sulphide-rich graphite-schists and black shales may form a primary source of ore-forming material, but that the mobilization, concentration, and re-deposition of the sulphide may be ascribed to tectonic deformations accompanied by hydrothermal activities. Many different views on ore genesis were expressed in other papers ; but in summary it seems fair to say that the Congress failed to bring forward any outstanding advance in metallogenetic theory. One of the most noteworthy factual contributions was a lengthy paper by a young Czech geologist on the origin of the Ordovician iron ores of Bohemia, competently presented in English and with the interventions in German and French devastated with equal fluency in these languages.

**Symposium on African Copper Ores**

In contradistinction to the above-mentioned discussions, the rules of the symposium on stratiform copper deposits held by the Association of African Geological Surveys wisely prohibited any debate on questions of ore genesis, attention being directed specifically to the accumulation of facts on the sedimentary petrology and sedimentary structure of the country rocks containing the bedded and disseminated ores. All contributions were prepared within a standard framework established by a questionnaire circulated prior to the meeting, with the result that most useful comparisons and generalizations could be arrived at. The summarized texts of these papers were not available in the Conference Proceedings, but were pre-printed in *La Chronique des Mines d'Outre Mer* for July, 1960. Accounts of the stratigraphy, petrography, sedimentology and mineralization were presented for Kilembe mine in Uganda, for the six principal mines in Northern Rhodesia, for the Union Minière properties in Katanga, for the Lake Moero zone in Belgian Congo, for Nyanga in French Equatorial Africa, and for the High Atlas of Morocco.

In these various regions stratiform copper deposits occur in sedimentary beds of almost every common lithological type, in strata ranging from non-metamorphosed rocks (Morocco) to rocks of high metamorphic grade (Kilembe). A general synthesis of some of the salient information on the deposits was presented at Copenhagen and was pre-printed in summary along with the abstracts. The full contributions, however, form such an important foundation for investigations into ore genesis, not only in Africa but throughout the world, that it is most desirable that they should be published in entirety.

**Geological Maps**

In 1956, at the twentieth International Congress in Mexico City, the Commission for the Geological Map of the World decided to produce a Geological Atlas of the World on a scale of 1 : 10,000,000, in a format size 45 cm. by 32 cm. (sheets 44 cm. by 56 cm.) This international map, in 18 sheets and 24 colours, has now been prepared for printing ; but for the project to be a reasonable one financially it will be necessary to have at least 6,000 subscriptions. Organizations and individuals interested in procuring one or more copies of the map are therefore invited to communicate, without commitment, with Éditions Géographiques de France, 121, Boulevard Saint-Michel, Paris, V$^{e}$, who are the prospective publishers on behalf of the Commission.

Sub-Commissions on International Metallogenetic Maps and International Tectonic Maps met repeatedly during the congress, and many outstanding productions were presented by the national organizations. The tectonic map of Europe compiled by the Russian draughtsmen from national maps submitted by the various European countries is a particularly beautiful and instructive production, now awaiting printing. A new tectonic map of Australia, hot from the press arrived in time to be exhibited on the last day of the meetings.

**The 1964 Congress**

For the 1964 congress, formal invitations were received from the delegates of the Government of India and also from those of the Government of New Zealand. It was explained that such a meeting in New Zealand would most appropriately coincide with the centenary celebrations of the Geological Survey there. Since, however, there had never been a meeting of the Congress in any Asiatic country, the proposal to hold the session in India received a majority vote. Representatives of Pakistan, Afghanistan and Ceylon expressed the hope that some field excursions would be held in their countries either before or after the 22nd International Congress in New Delhi or Calcutta.

# Ore-Dressing Notes

(8) *Electromagnetism.*

**Current Developments**

The scientific understanding of the nature of magnetic force appears to have commenced early in this century with the work of Langevin, in France. He explained diamagnetism and paramagnetism in terms of orbiting electrons, another French physicist, Pierre Weiss, following closely with his qualitative hypothesis for ferro-magnetic behaviour. This was based on the assumption that suitable atoms behave as though they were tiny bar magnets which could be influenced so that they aligned and behaved as a single large magnet. He introduced the idea of " domains " which to-day bases the theory of ferromagnetism. Much later quantum theory showed the nature of the aligning forces at work and provided experimental justification for these earlier hypotheses. However, before 1939 only a few ferromagnetic substances were in industrial use, but with post-war development in solid-state physics many new materials and outlets have been discovered.

Most electromagnetic applications of ferromagnetic materials follow the laws of Ampère and Faraday in their technical employment, the limitation to these uses in alternating-current practice being the frequency barrier. With the requirements for television, radar, etc., the well-known magnetic materials were useless, owing to impedance due to induced currents in the surface of the conductor. In the operating range 50–100,000 cycles per second transformer cores are usually built up from thin sections of metal, joined by insulating glue. This is sufficient to suppress eddying for many purposes. Usable frequencies can be pushed still higher by using tiny grains of metal consolidated by an insulating binder, but when millions of cycles per second (megacycles) are needed a powder-based core is almost useless. The key to further progress was forged by a group of Dutch physicists. They found that certain mixed oxides of iron and transition metals (the ferrites) had remarkable ferromagnetic properties which were combined with insulating properties sufficiently high to reduce current flow to negligible proportions, even when very large voltages were concerned. The magnetic properties of such oxides are termed " ferrimagnetism," a word which describes a state in which elementary magnetic atoms do not line up in parallel so as to form one large magnet, as is the case in ferromagnetism, but tend to oppose one another. The secret of their behaviour is in the crystal structure. The oldest known magnetic material, lodestone, is a natural ferrite. Its formula, $Fe_3O_4$ can be written $Fe^{++}Fe_2^{+++}O_4^{--}$. All ferrites contain their tri-valent iron ions and their oxygen anions in a two-to-four ratio, while the di-valent ion can be provided by any metallic atom small enough to fit into the crystal lattice. The general ferrite formula is $X^{++}Fe_2^{+++}O_4^{--}$. Resistance to flow of current is high because the crystals are ionic and the lower electron shells of their constituent atoms are filled. Magnetic strength, as always, is an effect produced by the spin of the electrons round their atomic nuclei. Paired electrons spin in opposite directions and therefore cancel out, but the atoms of such transition metals as manganese, iron, nickel, and cobalt contain at least one unpaired electron and thus are magnetic. The crystallographic structure is discussed by C. L. Hogan in *Scientific American* for June, 1960.

Even ferrites have limitations where the frequency range required in computers is concerned. A new type of crystal has been synthesized which has phenomenally high-frequency properties. This is a variant on garnet. In another field of application a new type of low-noise amplifier is now used in the paramagnetic substances called masers. A further class of substances, the superconductors which lose all their electrical resistance at very low temperatures—the cryotrons—is now used in fast-computer elements. Yet another development stems from fine-particle technology, in which synthesized-magnetic materials of ultra-fine size are used. Each such particle resists demagnetization more strongly than do compacted macroscopic particles.

(9) *Production.*

**Diamonds in South-West Africa**

The diamond-bearing gravels of the Skeleton Coast differ from those mined on the Rand in the non-adherence of some of the stones recovered to grease. Treatment at the Consolidated Diamond Mines of South West Africa now includes a conditioning treatment which restores this quality. Concentration of these gravels is described by S. W. Devlin in a recent paper.[1] This follows

[1] *J. S. Afr. Inst. Min. Metall.*, Apr., 1960.

his earlier paper (Nov., 1958) in which prospecting and mining methods were given. The mined gravels go to field-screening plants where *plus* 25 mm. and *minus* 1·91 mm. material is rejected, the inter-sized 15½% being transported to a central treatment plant, a movement of nearly 65,000 tons monthly. A small amount of conglomerate receives two-stage crushing to *minus* 14 mm. before joining this gravel.

Before 1950 the gravels were treated in specialized jigs which simulated the hand-sieve jigging method used in prospecting. In 1951 the pilot dense-media plant from Premier mine was transferred and took over the work of the jigs. The flow-sheet used to-day on the screened gravels and crushed conglomerate starts with tube milling, where 25% of the feed is rejected as slimes. This is followed by primary dense-media separation, where a further 71% of float is sent to dump. The 4% in the underflow next receives secondary dense-media separation to produce an underflow of 1·5% and an overflow from which the *plus* 8 mm. material is rejected by screening while the undersize returns to the head feed. Magnetic separation further reduces the dense-media product, magnetics being dumped. After further grinding and screening the products are either treated electrostatically or on grease tables to produce the concentrates, hand-sorted, and then dispatched from the area.

Feed to the primary D.M. cone at *minus* 25 mm. *plus* 1·91 mm. is washed in fresh water to remove salines and dust and treated in a cone of 11 ft. vertical depth with a differential density from top to bottom of 2·90–3·03, with a viscosity of its angular ferrosilicon medium of 16–18 centipoises. Feed rate does not exceed 112 tons per hour. Operating trouble with middlings particles is experienced, but both the primary and secondary cones are emptied (" dropped ") and cleared weekly. A 1% cut of the float is checked by tests in jigs. Concentration ratio in the primary cone is 16 to 1. The secondary cone, though much smaller, is otherwise similar. It uses rounded ferrosilicon at a density drop of 3·15–3·39 and an average viscosity of 22 centipoises. Concentration ratio is 3·3 to 1. Because of this higher-operating density some of the smaller diamonds report in the float, which is therefore screened on 8 mm., undersize being recycled to the primary cone. Operating efficiency of both cones is checked by radio-tracing activated diamonds through the circuit. From daily tests the efficiency of the primary cone is apparently 99·9% and of the secondary 100%.

Some of the final underflow is a banded ironstone having marked magnetic susceptibility; 20% of the underflow is removed by a specially-designed belt magnet, the balance being screened by trommels into four size ranges which receive separate attrition milling, where hard cores of cemented sand and magnetite are slimed off and the diamonds given the thorough scrub essential for final recovery. All " fines " (*minus* 6 mm. *plus* 1·91 mm.) are dried, dedusted, and fed at 95° C. to six-stage electrostatic separators at the rate of 1,000 lb. per hour per machine. The diamonds, which are poor conductors, receive positive charge and are pinned to the earthed rolls; 78% of the total recovery of diamond is made in this section.

As mined Skeleton Coast diamonds, as already noted, do not adhere to a greasy surface. This is due to superficial contamination by various salts and is partly removable by thorough scrubbing. The middle (*minus* 12 mm. *plus* 6 mm.), coarse (*minus* 18 mm. *plus* 12 mm.), and oversize (*minus* 25 mm. *plus* 18 mm.) products from attrition milling are separately treated. First they are conditioned in rotating barrels with caustic soda and fish-acid oil to give them a coating of sodium oleate. They are then strongly washed with fresh water to displace the oleate from gravels. The material is then fed on to two 20 in. wide belts working in series which travel 14 ft. per min. A ⅜-in. layer of special grease is continuously spread on at the head end and a thin layer is carved off by electrically-heated knives at the discharge end, carrying with it all adherent matter. This grease must be consistent over the working range of temperatures and not emulsify with the film of water flowing along the belt. This wash-water carries off the rounded gravels. All but a few oddly-shaped or badly-delivered diamonds are caught on the first belt and concentration ratio is about 100 to 1. Tailings are checked by jigging and recovery is considered to be 99·9%.

Some gravel still remains in the final concentrates from tabling and electrostatic treatment. This is removed by hand sorting. In addition some 19½% of diamond recovery is made direct during mining operations by hand picking. The balance, 80½%, is not touched by hand until the final sorting operation. The last treatment stage before

shipment to Kimberley is a wash with hydrofluoric acid to remove silica and clean the diamond surfaces.

(10) *Development.*

**Atacamite Recovery**

A 3,000 ton-day plant for the recovery of copper from atacamite ($CuCl(OH)_3$) should be operating at Mantos Blancos in North Chile before the end of 1960. Basically the process, which has been patented, starts with percolation leaching with sulphuric acid, followed by precipitation of the copper with sulphurous acid to produce cuprous chloride for smelting. Churn drilling having proved a first reserve of over 10,000,000 tons assaying just over 2% Cu, the erection of a treatment plant was considered justified. The copper oxychloride in the ore is associated with dacitic and andesitic gangue under a talus cemented by gypsum and other desert salts. Open-cast stripping will be used for mining, the ratio of overburden at first being 0·8 : 1·0 on 12-metre benches. A pilot plant has now been at work for two years and has overcome the difficulties presented by the high chlorine content of the acid-leach liquor. This would have prevented electro-metallurgical treatment since chlorine would attack anodes and cuprous chloride would deposit on the cathodes. Cementation methods are ruled out owing to shortage of suitable scrap iron in this part of the world.

Treatment will commence with crushing of the ore to *minus* $\frac{3}{16}$ in., by which point the disseminated copper minerals should be adequately exposed to chemical attack. After sulphuric leach the " pregs " will be reduced by gaseous $SO_2$ from the soluble form in the leach liquor ($CuCl_2$) to the basic CuCl, which is insoluble both in water and in acids. The resulting precipitate is to be mixed with limestone and coal, pelletized, dried, and smelted in oil-fired rotary furnaces. As there are no detrimental impurities in this ore a high-grade final product should be achieved. To produce part of the sulphuric acid called for by the work Chilean sulphur from volcanic sources will be burned and converted by the contact process.[1]

[1] MARKEL, W., *World Mining*, May, 1960.

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# Book Reviews

**Mineral Use Guide,** or Robertson's Spiders' Webs. By R. H. S. ROBERTSON. Paper boards, loose leaf, 44 leaves. Price 21s. London: Cleaver-Hume Press, Ltd.

In this " Guide " the author, who is director of Resource Use, Ltd., and Natural Resources, Ltd., of Pitlochry, presents 32 diagrams designed to show all the main uses of a rock or a mineral. These diagrams show some 52 such rocks or minerals as the centre of a web, a second inner ring showing the factors which determine the various applications set out in a third and outermost ring. Since, the author says, the pattern of mineral utilization changes no attempt is made to gauge the relative importance of the various uses. There is an index and also a useful glossary.

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**Babylon to Birmingham:** An Historical Survey of the Development of the World's Non-Ferrous Metal and Iron and Steel Industries, and of the Commerce in Metals since the Earliest Times. Compiled and Edited by H. G. CORDERO and L. H. TARRING. Cloth, octavo, 498 pages, illustrated. Price 60s. London: Quin Press, Ltd.

Compiled and edited by the joint editors of the *Metal Bulletin* this readable volume gives the results of a considerable research and an epitome of the knowledge the authors have gained in some 40 years' close study of the world's metal industries. It is set up in five parts, the first entitled " From the Dawn of History to the 19th Century." In the second part the operation of " The London Metal Exchange in Peace and War " is entertainingly reviewed, while the third surveys " More Historical Aspects." Of more general interest, perhaps, is Part IV " Stories of the Metal Trade," which in 45 chapters gives many interesting side lights on a specialized trade. The work concludes, in Part V, with some useful statistics.

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**The Key to Accounting and Costing.** A graphical elucidation for technical and business men. By J. A. R. TAINSH. Cloth, Small octavo, 119 pages, illustrated. Price 14s. London: Charles Griffin and Co., Ltd.

The author of this neat little volume, a member of a firm of international business

consultants, sets out a pictorial analysis of accounting based on a " true balance," or a pair of linked balances symbolizing the two main branches of accounts. This, he considers, is the readiest way for a learner to grasp the patterns he may be faced with in everyday practice. As illustration the author considers the case of a typical firm, after some preliminary observations describing the day by day book entries and using special diagrams to illustrate the principles of business operation.

The book is not, of course, for the professional accountant, but written for technical and professional men who need a really effective explanation of accounts. There is, in addition, a special section devoted to practice in other countries.

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**A Revised Geological Time-Scale.** By ARTHUR HOLMES. Paper covers, pp. 183–216, illustrated. Price 3s. 6d. Edinburgh : Oliver and Boyd, Ltd.

This reprint from the *Transactions* of the Edinburgh Geological Society gives Professor Arthur Holmes's revision of his original time-scale constructed in 1947. That, it is explained, was based on certain assumptions recently shown to be incorrect. The extended scale now set out shows, among other things, that important orogenic and plutonic phases of a major geological cycle occurred at about the close of Precambrian time and early in the Ordovician.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2

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# Engineering Log

Rhenium is still too scarce, and too expensive, to be considered as a material for general design applications. However, it possesses the highest melting point, at 5,756° F., of all the refractory metals except tungsten and in specialized applications the use of rhenium-based alloys is justified by the properties they possess in combination with the high melting point. Rhenium is the most refractory of the metals which are capable of electrodeposition from aqueous solution and superior to tungsten in its resistance to deterioration caused by the water cycle. It has low contact resistance and does not form stable carbides, is more ductile than tungsten at room temperatures, and when joined with molybdenum or tungsten has good thermo-electric mechanical properties. Unfortunately data on yield strength for rhenium are lacking and this is one of the drawbacks in most high-temperature data. Instrumentation problems in the higher temperature ranges make it difficult to determine yield data during tests.[1]

* * *

During April and May of this year the Australian Bureau of Mineral Resources completed airborne surveys of nearly 16,000 sq. miles in central New South Wales. Two areas were surveyed, one lying mainly to the south of Bourke, the other comprising the Forbes-Parkes and West Wyalong districts. The surveys were carried out with the Bureau's D.C. 3 aircraft equipped with recording magnetometer and scintillometers and systematic coverage of the areas was achieved by flying grids of parallel lines spaced a mile apart. In the Forbes-Parkes area, which includes a former important gold-producing district, the recorded magnetic data showed numerous anomalies which, when presented accurately in map form, are expected to assist considerably in the geological mapping of the area. In addition, several centres of higher than average radioactivity are considered worth inspection for possible radioactive minerals.

* * *

An interesting new survey technique is being used for the British Petroleum Company in its search for oil in Libya. Known as the " Geograph " it is a variation of the seismic survey in which small shock waves are used to detect the position of the various rock strata beneath the ground surface. In the conventional seismic survey these shock waves are generated by detonating small explosive charges in shot holes drilled a few feet into the ground. With the Geograph survey the shock waves are set up by dropping a heavy steel weight on to the surface. This weight, of some 6,000 lb., is mounted on a truck known appropriately as the " Thumper." The weight is raised by an hydraulic system and is released by an electro-magnet, falling a distance of nine

[1] *Materials in Design Engineering*, June, 1960.

feet. While the individual shock waves with the Geograph are much smaller than those created by explosive shots, the integration of the results from several weight drops by special electronic apparatus enables high-quality records to be obtained. An advantage of the Geograph method, it is claimed, is that it eliminates the cost of explosives and of drilling shot holes. The latter can be a major item in some parts of Libya because of the hard limestone surface, calling for expensive rock-bits to penetrate it.

* * *

The Dow Chemical Company has introduced a new polyethylene moulding compound called "Surfaseptic." This has been designed with the express purpose of fighting bacteria and the research team responsible for its development says that the compound is particularly effective as an active killer of staphylococcus organisms, which have proved themselves an increasing menace as disease producers, since they are resistant to compounds used to fight other types of bacteria. The new compound will be available in grain or pellet form. It is expected to be used in many ways and to be employed in the manufacture of such products as toys, waste baskets, door knobs, and telephone head sets and arm rests. Surfaseptic is expected to carry little or no price premium.

* * *

Reports on structural damage following the recent earthquakes in Chile throw interesting light on ways in which this kind of disaster could be averted. Chile's central provinces were shattered after a week of almost continuous tremors, landslides, and waves. The reports indicate that lack of careful subsoil investigation before building accounts for many cases of structural failure during the earthquakes, certainly in modern buildings not directly affected by landslides or ocean wave action. Most buildings of recent construction took the record shock well, but even where considerable allowance had been made for seismic shock in superstructures, poor soil conditions frequently resulted in collapse of buildings. At Puerto Montt, the Hotel Turismo, with its eight tower floors rising at one side of a ground floor and basement foundation, gave way when an earthfill settlement allowed one side of the single storey section to sink four feet. When this base section settled the entire base section shifted and sank, folding the basic structure of the tower, although the upper floors held out. At the same city of Puerto Montt the port installations disappeared completely under water from slippage. A reinforced concrete frame hospital at Valdiria was badly damaged on six levels and in Concepcion an elevated water tower, capacity 5,600 gallons, dropped when joints between the tank and its reinforced-concrete columns gave way, while another tank, of capacity 2,250 gallons and again of reinforced concrete, fell when its single supporting column was wrenched from the foundations. As a result of insufficiently dense subgrade material 900 ft. of dyke in a naval base area north of Concepcion slipped from its base, while the earth fill behind cracked parallel to the dyke line, which it followed into the water. To the South of the city the staircase-like Bio-Bio River Bridge was damaged following earth-slips. Spans slipped off their piers at one end only and dropped intact into the river bed. Bridges designed with point bearing only collapsed during the tremors, while the smaller reinforced-concrete bridges that extended over their abutments at either end were not affected.[1]

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The Channel Tunnel Study Group's favourable report on the technical and financial aspects of the proposed tunnel between England and France aroused much public interest. Two main schemes were put forward—a system driven in the homogeneous and impermeable chalk marl which lies at the base of the Lower Chalk and a tunnel resting in a trench dug on the sea bed; the first of the these is favoured. Driving of two main rail tunnels would be preceded by a pilot bore, called the "service tunnel." This would explore the ground, provide multiple points of entry for a main attack, and in due course be of permanent use. It would also drain the work and facilitate the use of grouting techniques in the event of fissured ground being encountered. A modern version of the Beaumont rotary-head tunnelling machine would be used, perhaps with hydraulic transport of the spoil to a convenient outlet up to the sea bed. Each of the two main tunnels would be 21 ft. 4 in. in internal diameter.

[1] *Engineering News-Record*, June, 1960.

# News Letters

## SOUTHERN AFRICA

*August 27.*

**Union Affairs.**—There has been some kite-flying about intensified import controls in the face of the wind of a steady and sustained decline in the Union's gold and exchange reserves in recent months. The decline has been evident mainly in foreign exchange. On August 5 this amounted to a meagre £523 but in the following week there was an improvement to £2,130,000 which is expected to improve further as receipts from wool sales accrue. On June 30 this year the exchange account reflected a credit of £2,620,000, against £35,200,000 on March 31 and £47,990,000 on December 31 last. The gold holdings have been relatively stable, declining from £84,430,000 on December 31 to £81,390,000 on August 12 last. The Minister of Economic Affairs more recently eschewed any possibility of an intensification of import controls. He expressed the hope that the drain on the reserves has seen its worst and added that " the Government is not considering import control at all. It is a crisis measure and we are by no means in a crisis. . . . The economy on the whole is still in a very sound condition." A major trade move in Europe is being planned through reinforcement of existing trades and the establishment of new ones.

Over the first half of 1960 exports and imports were respectively £227,124,000 and £281,100,000 and the adverse balance £53,976,000; against £205,352,000, £243,572,000, and £38,220,000 in the corresponding 1959 period.

Gold production in the first half of 1960 compared with that over 1959 reflected little or no abatement of the rise in working costs. The average cost per ton milled rose further. Reductions in individual instances were recorded in 18 cases, there were 32 increases, and three unchanged. The average cost per ounce declined, but in individual instances there were 15 reductions and 38 increases. In respect of uranium oxide treatment costs per ton treated increased to 12·146s. a ton in the 1960 period from 11·866s. in 1959; per lb. produced costs increased to 23·661s. from 22·686s. per lb. In 1960 35,432,700 tons milled yielded 10,314,568 oz. fine and miscellaneous output was 226,230 oz. For uranium oxide 12,122,437 tons treated yielded 6,223,076 lb. output with miscellaneous output of 167,906 lb.

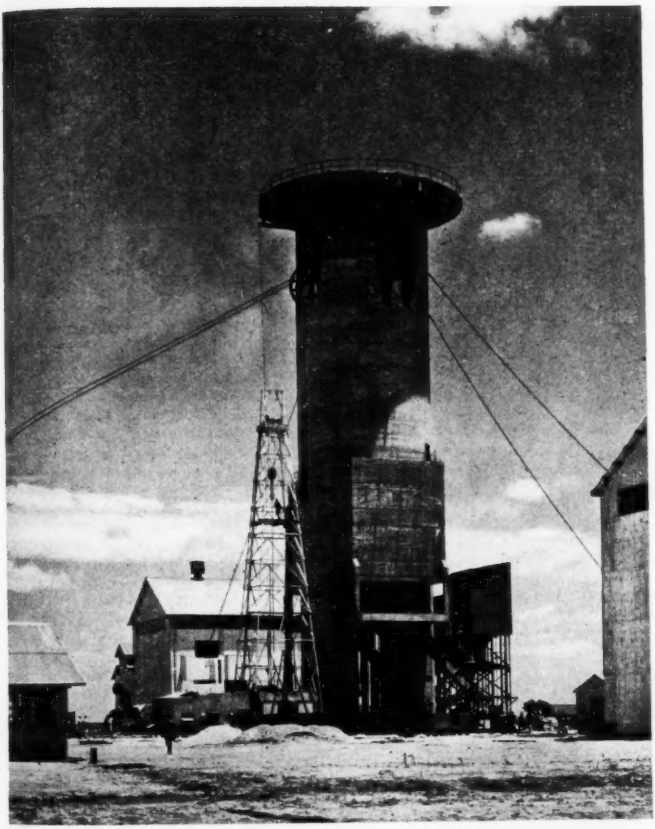
In his annual address the Governor of the South African Reserve Bank, Dr. M. H. de Kock, commented that in the 1958–59 year total expenditure on consumption and gross investment in both the internal and external accounts reflected a decline of about £8,000,000. Compared with the average annual increase of about £150,000,000 in the 1949–50 to 1955–56 period, the gross national product improved only by £52,000,000 and £83,000,000 in the 1957–58 and 1958–59 years, with new gold output a major steadying influence against substantial declines in exports. In respect of 1959–60 available data indicates a much more favourable tendency. A distinct revival in economic activity became evident and persisted to the year's end. However, less favourable aspects have become evident and the gold and exchange reserves have declined, which decline has dominated the monetary and banking sector and reduced liquidity and induced greater calls on bank credit. The major factor in this has been the unsettling of overseas confidence in South Africa by Bantu unrest and demonstrations. The immediate prospects for avoiding a deficit on the external capital account appear discouraging and any long-term improvement in the outlook is intimately associated with a sufficiently revived confidence overseas. The Union still needs a moderate net annual inflow of capital to finance all new development projects necessary both to maintain and increase the general standard of living.

**Transvaal.**—Msauli Asbestos Mining and Exploration has commissioned a considerable amount of new equipment which on the longer term should be reflected in better returns, although the immediate cost structure will be adversely affected. The company has initiated work on its new hydro-electric plant. The new equipment commissioned consists mainly of mechanical shovels, conveyors, and transport vehicles.

**Orange Free State.**—President Brand Gold Mining, in a bore-hole 3,050 ft. south of No. 2 Shaft—that is, in the western section of the down-cast section of a major fault system—intersected the Basal Reef at 6,092 ft. with values of 355 in.-dwt. in a complete exposure. Further to the south, on the upcast side of the fault, bore-hole depths of the reef were about 4,500 ft. to 5,400 ft. The bore-hole is in a zone where values are expected to be lower than the average representative of the mine as a whole. The indicated bore-hole grade range was 588 to 917 in.-dwt; the last ore-reserve grade was 977 in.-dwt. The development programme is *inter alia* now being directed to extending operations in the deep-lying zone in which the bore-hole was sited.

To be sunk to a depth of respectively 6,300 ft. and 6,000 ft. the main hoisting and the ventilation components of the No. 3 Shaft twin-shaft system at President Steyn have intersected the Basal Reef at respective depths of 4,643 ft. and 4,579 ft. with values of 173 and 175 in.-dwt. respectively, the former resulting from an incomplete exposure due to faulting. Both results are below the indicated bore-hole grade range of 270 to 350 in.-dwt. and the last ore-reserve grade of 379 in.-dwt. In the main hoisting component subsidiary loading arrangements will be established at 50 Level Station to facilitate an early start to development and stoping in the upper levels after installation of the permanent shaft equipment. The lower levels will then be prepared for operations.

Free State Saaiplaas Gold Mining has initiated the preparation of stope faces for the commencement of stoping in October and reef development has been started in the No. 2 Shaft area. Adverse factors in recent months included unpayable ground on the upreef side of No. 1 Shaft and step-faulting which, with a flatter dip than originally estimated, necessitated longer cross-cuts to reef on the down-dip side towards No. 2 Shaft. Milling, now scheduled for October, is expected to be built up to 50,000 tons a month by next January, 75,000 tons by September, 1961, and 100,000 tons by about March, 1962. The faulted conditions and accompanying water-bearing fissures had retarded completion of the connecting haulages between the two shafts. This and the adverse factors mentioned has upset the time schedule for production, which was deferred by two months or so. Fears have been expressed that the mine might turn out another Freddies Consolidated. So far it would appear that



**No. 3 Shaft, Loraine.**

insufficient reef development has been accomplished to confirm or refute such a prognosis, which the bore-hole results do not seem to justify.

**Loraine Gold Mines.**—The recently completed twin-haulage on 52 Level, connecting No. 2 Shaft in the Loraine section with No. 3 Shaft in the Riebeeck section of Loraine Gold Mines, Ltd., was driven in all through about 22,000 ft. of ground. Of this distance about 15,000 ft. was advanced in the period from September, 1958, to June 9 this year, when the final holing was completed. In that period 30,000 ft. were excavated (in both components) involving the breaking of 433,000 tons of rock and its disposal. In March this year a total of 2,932 ft. were excavated, equivalent to breaking and disposing of 30,000 tons of rock. Since all the operations were conducted from one side, from No. 2 Shaft in the north, the haul was increased with every foot advanced and in the final stages presented the operating personnel with a problem of its own. The great length of haulage was necessitated by the peculiar feature of the formations, that the multi-banded Elsburg Reefs occur with a strike-length of about 25,000 ft. and what is expected to be a relatively narrow extent on dip. The great length of the haulage therefore provides for the many points required to open up complex and somewhat erratic ore-bodies of the Elsburg horizon in the extreme south-western Loraine and in the adjoining Riebeeck section to the south. In all, and including the 52 Level, six haulage systems at vertical intervals of 200 ft. are planned. The 48 Level twin-haulage has already been advanced southwards from the No. 2 Shaft into the northern Riebeeck section. The 50 Level system is being driven northwards from No. 3 Shaft. Eventually another shaft will be sunk in the Riebeeck section. The site, which may be in the extreme southern Riebeeck section, has not yet been finally decided. The existing hoisting capacity, of both Nos. 2 and 3 Shafts, provides for a mill feed of 150,000 tons a month; this suggests that the current gold plant capacity of 80,000 tons to 96,000 tons a month may be expanded further.

*52 Level Twin-Haulage Data.*—Both components were cut 10 ft. wide and 12 ft. high, about 40 ft. apart between centres, and interconnected by inclined cross-cuts at intervals of 1,000 ft. in the zone from No. 2 Shaft to the northern Riebeeck section, where this interval was shortened to 500 ft. One component will function as a high-speed haulage, the other as the return airway.

*Development Crews.*—The crews were employed on three 8-hr. multi-cycle shifts per day. The aggregate composition of the crews was one mine overseer (or mine captain); four shift-bosses; six developers; three pipe-and-track men; two construction men at the back, and one man on transport duties. All these were white personnel. A total of 200 native mine-workers was employed on drilling; rock-loading—manual and mechanical; the laying of pipes, tracks, and ventilation columns; driving locos, and such other duties as transport and operational maintenance.

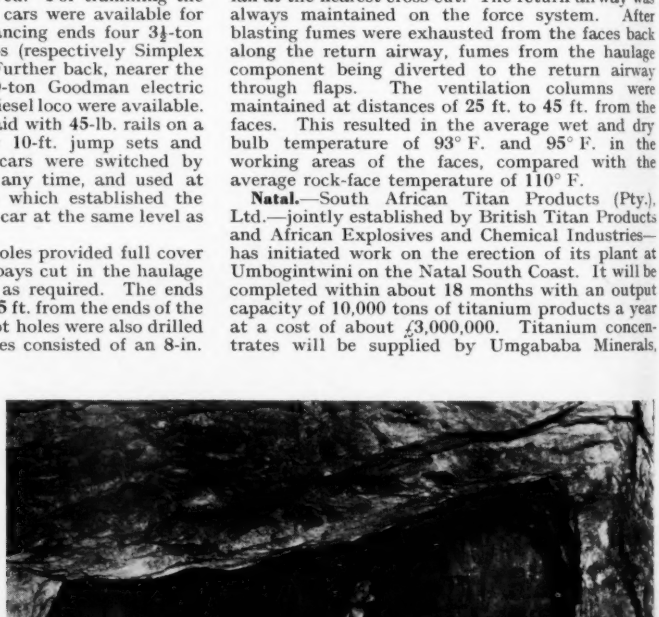
*The Working Cycle.*—The average cycle was made up as follows: Cleaning, 55 min.; drilling, 50 min.; charging-up, 10 min.; blasting, 5 min., and re-entry, 10 min., a total of 130 min.

*Rock-Loading and Transporting.*—An Eimco 40 mechanical loader was operated in each end with one similar loader available as standby for both ends. Mechanical loading was supplemented by manual lashing, which was also used to clean out the cross-cuts and bays in the haulages. A best cleaning time of 40 min. was achieved. For tramming the rock, 86 4-ton side-tipping cars were available for both ends. Near the advancing ends four 3½-ton and three 5-ton diesel locos (respectively Simplex and Progress) were used. Further back, nearer the No. 2 Shaft area, two 10-ton Goodman electric locos and a 9-ton Simplex diesel loco were available. The permanent track was laid with 45-lb. rails on a 30-in. gauge, extended by 10-ft. jump sets and 15-ft. sliding rails. The cars were switched by traversers, one per end at any time, and used at 100-ft. centres of the type which established the rail elevation of the trolley car at the same level as the rail.

*Drilling.*—500-ft. grout holes provided full cover at all times, drilled from bays cut in the haulage components and cemented as required. The ends were always not less than 125 ft. from the ends of the cover holes. Four 12-ft. pilot holes were also drilled per round. The service lines consisted of an 8-in. air-line in the haulage and a 6-in. air-line in the return airway, 4-in. water columns, and 2-in. waterblast lines. The air and water columns terminated in reinforced manifolds, with 3 in. by 2 in. air-hose and 1 in. by 1 in. water-hose extensions to the drilling platforms, which carried water and air manifolds and on which six drills were operated with two other drills operated on the floor. For both ends 40 in. by 3 in. Atlas Copco Jet (BBX) rockdrills and airlegs were available, together with 96-in. Sandvik Coromant T.C. drill steel (1½-in. chisel bits). These machines drilled a 38–40 standard drag round with a 9-hole drag. The charge consisted of 1½-in. gelignite with shot exploder and igniter cord for firing. The best advance in 24 hr. was 120 ft. in 20 rounds in both ends and 66 ft. in one end.

*Ventilation.*—Of the 130,000 c.f.m. provided by the main forcing fan on 52 Level 70,000 c.f.m. were delivered to the two haulage components. Each face was supplied at the rate of 13,500 c.f.m. from two 22½-in. columns fitted with a reversible booster fan at the nearest cross-cut. The return airway was always maintained on the force system. After blasting fumes were exhausted from the faces back along the return airway, fumes from the haulage component being diverted to the return airway through flaps. The ventilation columns were maintained at distances of 25 ft. to 45 ft. from the faces. This resulted in the average wet and dry bulb temperature of 93° F. and 95° F. in the working areas of the faces, compared with the average rock-face temperature of 110° F.

**Natal.**—South African Titan Products (Pty.), Ltd.—jointly established by British Titan Products and African Explosives and Chemical Industries—has initiated work on the erection of its plant at Umbogintwini on the Natal South Coast. It will be completed within about 18 months with an output capacity of 10,000 tons of titanium products a year at a cost of about £3,000,000. Titanium concentrates will be supplied by Umgababa Minerals,



**Hole-Through on 52 Level, Loraine.**

Ltd., of the Anglo American Corporation group, from its works on the Natal South Coast.

**South-West Africa.**—Following on the erection of a custom copper smelter, not yet completed, the Tsumeb Corporation has formulated plans to erect a lead counter-part in its general programme of expansion. This is expected to be completed and commissioned about mid-1963 with a capacity of about 90,000 tons of refined lead a year. The programme of expansion includes development for production at the corporation's Asis mine.

**Basutoland, Bechuanaland, and Swaziland Protectorates.**—Sir Gordon Hadow, a member of the Economic Survey Mission which conducted an on-the-spot survey of the territories in 1959, has been appointed Development Adviser for the three territories. The report of the Mission, recently released, has fully endorsed the development programme planned for the 1960–64 period, but recommends that it should be considerably expanded and accelerated. The report notes the need for vocational and technical training, more agricultural research for improved facilities for the marketing and transport of production, for better roads, for aerial and hydrological surveys, and for telecommunication facilities. The recommendations are to be considered by the U.K. Commissioner for the territories and the U.K. Secretary of State.

Preparatory to an extension and expansion of operations the Swaziland Iron Ore Development Co., of the Anglo American Corporation group, has given notice of an increase in capital to £225,000 from £125,000. There have been unofficial reports of negotiations proceeding for long-term contractual exports to Japan *inter alia* and for constructing a rail link to facilitate shipping through Lourenço Marques. More recently the prospecting programme was intensified at the company's Bomvu Ridge hæmatite deposit in the Mbabane district, where surface and underground diamond drilling, surface trenching and pitting, geological mapping, and driving an adit into the main ore-body to obtain bulk samples for testing have been in progress. In addition to its current rights the company has been granted an exclusive prospecting licence over a siderite deposit in the same district and preliminary prospecting operations have been initiated.

## BRITISH COLUMBIA

*August 4.*

**Canadian Institute.**—The Annual Western Meeting of the Canadian Institute of Mining and Metallurgy is to be held in Vancouver from October 17 to 19 inclusive, 1960. " Future Markets for Western Canadian Mineral Production " has been chosen as the theme of the meeting because of the concern of the producers and the favourable impact of Japanese purchasing of iron, copper, nickel, and coal in British Columbia and Alberta. The technical programme includes a panel session to discuss the theme on the first afternoon. A film session and a second panel session, to discuss " Research and Its Relationship to Western Canadian Minerals," are also to be held. Two technical sessions have been allocated to geology, metal mining, and reduction metallurgy and one each to industrial minerals and coal mining.

**Cominco.**—The Consolidated Mining and Smelting Co. of Canada reports a large increase in earnings during the first half of 1960. Although the sales value of all products, at $64,281,000, was almost identical with the $62,826,000 of the first six months of 1959, operating profit after deducting depreciation and taxes and all expense of mining, smelting, chemical and fertilizer manufacture, selling, and administration was $11,483,000 ($7,441,000). After adding $1,660,000 ($1,117,000) from income from investments and $147,000 ($6,000) accruing from net profit on sale of securities, the net profit for the six-month period was $13,290,000 ($8,564,000).

**Placer Development.**—The quarterly report of Placer Development advises shareholders that the directors expect a large amount of funds will be required for development of several large-scale mining ventures. During the final three months of its fiscal year, ended April 30 last, Canadian Exploration, Ltd., produced 8,850 tons of concentrates from 93,246 tons of ore grading 2·3% lead and 4·44% zinc. For the full year production was 33,764 tons of concentrates from 346,886 tons of ore averaging 2·6% lead and 4·3% zinc. The estimated gross operating profit was $1,027,000 reflecting the higher zinc prices obtaining in the later year. With semi-proved ore estimated at 17,034,000 tons averaging 2·04% copper and 19·8% iron, plans are being made for production from the company's Craigmont mine, near Merritt.

**Vancouver Island.**—Shareholders and bondholders of the Coast Copper Co. at separate meetings on August 2 approved plans to bring the company's copper property near Port McNeill, Vancouver Island, into early production at 750 tons daily. The Consolidated Mining and Smelting Co. of Canada, Ltd., which holds approximately a 96% interest in Coast Copper, has agreed to provide $680,000 to meet all expenditures relating to the production of ore. Cominco will also provide a 750-ton concentrator, power plant, camp, and all auxiliary buildings and equipment, to be supplied on a rental basis of $1·25 per ton of ore treated with copper at a basic price of 30 cents per pound (" U.S. export " refinery) and varying 7½ cents per ton with each rise or fall of one cent in the price of the metal. Coast Copper was organized in 1916. Underground exploration was carried on intermittently from that time until 1930 and this work, which was carried out and largely financed by Cominco, outlined a small deposit of copper ore. In 1955 and 1956 a detailed geological appraisal of the property followed a check diamond-drilling programme and the result placed ore reserves at 2,000,000 tons assaying 2·5% copper, with very little chance of finding more ore. The plan for the present is to proceed on a salvage basis from the outset.

**Queen Charlotte Islands.**—Silver Standard Mines is re-negotiating with the Sumitomo group for a sales contract and for some pre-production investment to prepare the Harriet Harbour iron deposits for early output. Mr. Ridgeway W. Wilson, the managing director, told the recent annual meeting of shareholders that the Japanese market for iron is strong and is increasing at approximately 15% annually. The Japanese ore buyers are currently offering about $9·70 per ton for 62% concentrate and, after an ocean freight rate of $5·50 per ton, are landing the beneficiated product at smelter for approximately the same as the United States price at Duluth, he said. With a premise of 350,000 tons of iron annually as an economic minimum, he saw little chance of an integrated iron and steel industry on the B.C. coast for many years to come. However,

he did concede there was a possibility United States Steel might build a plant in San Francisco.

**Lillooet.**—Bralorne Pioneer Mines reports production as 37,810 oz. of gold, valued at $1,323,350 ($35 per oz.), from 57,434 tons of ore grading 0·66 oz. per ton in the second quarter of 1960. The company's Bralorne division produced 28,184 oz. from 37,859 tons assaying 0·744 oz. per ton and the Pioneer division, 9,626 oz. from 19,575 tons, assaying 0·49 oz. per ton. Owing to the lower grade of ore being mined and the exacting terms demanded by the International Union of Mine, Mill, and Smelter Workers in negotiating a renewal of the labour agreement, the company suspended all mining operation of the Pioneer division at the end of July. However, the workings are not being permitted to flood and a vigorous underground-exploration programme is in progress. The company's option on the Ace gold prospect in the lower Bridge River valley is considered by the Bralorne Pioneer management as a definite asset. Important gold values have been found over mineable widths for a length of 750 ft. and over a vertical interval of 400 ft. Driving is in progress and studies are being conducted to determine if Ace ore can be treated economically in the Pioneer cyanide mill.

**Cariboo.**—The Cariboo Gold Quartz Mining Co. is encouraged by the discovery of coarse placer gold in the Mosquito Creek fault area of the company's holdings. The gold is reported to be coarse and crystalline and is thought to have been found very close to its lode source.

**Greenwood.**—The management of Camp McKinney Gold Mines has been taken over by Giant Mascot Mines which holds 40% of the issued stock of the former and, through an associate, controls an additional 20%. Recent development work has been encouraging. A drill hole at *minus* 30° cut 4 ft. of ore assaying 4·32 oz. of gold per ton at a depth of 40 ft. below the 5 level and a second hole, 80 ft. distant, cut 3 ft. of 1·6-oz. grade at 61 ft. below the same horizon. Shipments of high-grade gold ore are being made directly to the Trail smelter.

Continental Consolidated Mines has announced that its considerable stockpile of copper-gold ore at the Stemwinder shaft will be milled on a custom basis by the Phoenix Copper Co., Ltd., a subsidiary of the Granby Mining Co. Continental is to start a diamond-drilling programme with a view to warranting establishment of open-pit mining methods for the recovery of ore on its property at Phoenix.

**Yukon.**—Gold recovery by the Yukon Consolidated Gold Corporation for the months of May and June was valued at $590,000, as compared with $398,000, in the same period of 1959, Mr. W. A. Arbuckle, the company president, told the recent annual meeting. It was the first such meeting of the company to be held in the Province, in which its executive and head office is situated. The president expressed confidence that 1960 operations would earn sufficient operating profit to warrant another stock dividend this fall, although he warned that the apportioned operating cost would be higher due to the elimination of the company's largest dredge. The company is vigorously to pursue its prospecting programme in Yukon and its exploratory effort in New Brunswick, in partnership with the Consolidated Zinc Corporation of Canada, Ltd.

**New Zealand.**—South Pacific Mines, Ltd., plans to erect a 300-ton cyanide mill at Waikino for the recovery of gold and silver from the Ohinemuri River sand and the tailing from the 70-year operation of the Waikino battery. The recommendation came from Dr. A. G. Pentland, consulting geologist, after receipt of the report of Wright Engineers, Ltd., covering that firm's metallurgical research. The gross cost of the installation is estimated at $345,000. The river sand has a proved deposit of 498,000 tons averaging 0·091 oz. gold per ton and the battery tailing 22,000 tons grading 0·395 oz. The gross value of mill feed is accordingly $2,300,374, with gold at $34·30 per oz. and silver at 85 cents per oz. Wright Engineers have successfully recovered 90% of the contained gold and 70% of the silver, on which basis the recoverable value is placed at $1,981,936. There are indicated extensions concerning which Dr. Pentland states: "Test work on this material has not been completed to the point where final reserves and grade can be accurately assessed, but sufficient work has been performed to provide an indication that a very large part of the additional tonnage can be treated at a profit. Thus it is clear that the net profit from the whole operation will be over 1,000,000 dollars."

## EASTERN CANADA

*August 26.*

**Cobalt.**—A new silver producer, Deer Horn Mines, Ltd., is now operating in the Cobalt area. The mill commenced work in June and is now treating some 100 tons daily of ore running 20 oz. to 45 oz. of silver per ton. Before the plant started work the company had been shipping high-grade ore.

**Blind River.**—The combined operating results of Algom Uranium Mines, Ltd., Milliken Lake Uranium Mines, Ltd., Northspan Uranium Mines, Ltd., and Pronto Uranium Mines, Ltd., have been announced by the Rio Tinto Mining Co. of Canada, Ltd., for the six months ended June 30. The gross revenue for the period is given as $72,738,000 and the net profit as $15,201,000, against $6,349,000 for the comparable period of 1959. The tons of ore milled were 3,019,000, as compared with 3,226,000. Letters patent of amalgamation were issued to Rio Algom on June 30, 1960, and the figures given represent the result of operations of the four amalgamated companies for the six months prior to the amalgamation. Operations at Pronto's uranium mine ceased at April 30, and at Northspan's Lacnor mine at June 30, so as to give optimum effect to the stretch-out provisions of the Government's announcement of November 6, 1959. The revenue shown includes the total value of production at selling price, the figures being subject to audit and year-end adjustments.

**Sudbury.**—The report of the international Nickel Co. of Canada, Ltd., and its subsidiaries for the six months ended June 30, shows net earnings in terms of U.S. currency of $43,902,000 after all charges, depreciation, depletion, taxes, etc., equivalent to $1·50 per common share. For the first six months of 1959 net earnings were $38,391,000, or $1·31 per common share. Deliveries of nickel in all forms during the second quarter were less than the record high deliveries made in the first quarter, the report stated. "The company is continuing to augment its supplies by nickel acquired in connexion with the reduction of the United States Government's procurement contract obligations. Inventories and cost of sales continue to reflect the cost of this

nickel, which was purchased at market prices." Capital expenditures of $36,179,000 were made during the six months, as compared with $30,527,000 for the first six months of 1959.

**Manitouwadge**—In the six months to June 30 last Geco Mines milled 666,730 tons of ore, the operations resulting in an estimated net profit of $3,155,000. Shareholders are informed that during June the balance of the Mining Corporation of Canada loan was retired and that underground development was proceeding satisfactorily. Capital expenditure during the six months' period amounted to $430,700.

**Manitoba.**—The report of North Rankin Nickel Mines for 1959 shows a profit of $260,573, which compares with $730,454 for the previous year. The adverse effect arises, it is stated, owing to the treatment of lower-grade ore, increased marketing charges, and adverse exchange charges on the sale of nickel in U.S. markets. During the 1959 shipping season, which lasted from August 11 to October 17, 22,700 tons of concentrate were shipped out. The ore reserves at the mine also show a substantial decrease, being 276,000 tons at the end of 1959, as compared to 363,500 tons at the end of 1958.

**Quebec.**—In the six months to June 30 last the Quemont Mining Corporation milled 428,240 tons of ore and made a profit of $1,041,000, while in the same period the Normetal Mining Corporation milled 188,575 tons for a profit of $826,000.

## AUSTRALIA

*August 20.*

**New Company.**—Of recent formation Commonwealth Mining Investments has for its objects mineral exploration and investment in sound mining propositions and it includes men prominent in Australian technical and investment spheres. The company has made a cash placement of 3,500,000 shares of 10s. each at par with a subsidiary of Consolidated Gold Fields of South Africa, Ltd., and the new capital will permit Commonwealth Mining Investments to undertake further expansion and allow the development of Australian mineral potential on a greater scale. The chairman of the company is Mr. Julius Kruttschnitt, of Mount Isa Mines, Ltd. Investment possibilities outside Australia will also be considered.

**North Queensland.**—The Federal Government Mining Committee has been examining the mining potentialities of North Queensland. The Weipa bauxite field and the Mount Garnet tin field were inspected, as well as Mount Isa mines and Mary Kathleen uranium mine. A particular recommendation which will be made is directed to encouragement of the search for new tin deposits. Australian production is about 2,200 tons of tin per year and it is evident that requirements within a very brief period will reach 5,000 tons annually, which will mean importation of tin to a value of £A3,000,000 approximately annually. North Queensland offers opportunity for planned prospecting and the New England district of New South Wales is another area which offers legitimate scope for prospecting. Tin mining has never been really popular with Australian investors, having been mainly in the hands of weakly capitalized companies, so that if the industry is to be rejuvenated strong Government encouragement is essential.

Copper mining in North Queensland is expanding through the Japanese demand for Australian copper. There is a large number of small copper deposits in the north and a project is being examined for the provision of a treatment plant for the ores of small producers. The proposal is limited to the production of saleable concentrate and smelting is not under consideration.

**Mineral Production.**—The gross value of mineral production in Western Australia in 1959 was a record at £A21,796,605, £A1,225,904 more than production in 1958. Gold production totalled £A13,541,929, the third highest annual value recorded for this mineral; dividends by gold-mining companies aggregated £A2,093,984, an increase of £A26,158 on 1958. To the end of 1959 the total distribution in dividends by the State gold-mining companies was £A62,383,544, a striking instance of the importance of the gold-mining industry to a community. Gold ore treated last year was 2,959,202 tons, 61,870 tons less than in 1958, the gold yield being 866,609 oz. fine, the third highest since 1941. For the first time royalty totalling £A61,085 was collected under legislation passed in 1958, but gold is excluded from liability. Royalty on some other minerals was excluded because of the depressed state of the metal markets. Exported iron ore—presumably to the Eastern States—contributed £A41,874 to the total. Activities in prospecting for iron ore have been intensified and drilling has been in progress at Tallering Peak, while geological examinations have been made at Koolyanobbing, Mount Goldsworthy, and the Weld Range with a view to drilling. There is speculation as to whether the embargo on the export of iron ore will be lifted or relaxed. This matter is regarded as of particular importance to Western Australia and there is some optimism that some modification will be made in the policy. This will result from a recent resurvey of the Commonwealth's iron-ore resources, which appear likely to exceed previous estimates.

Production of Australian copper reached a record in 1959. The value of exports of refined metal and concentrates rose from £A4,500,000 in 1958 to £A10,300,000 in 1959, mine production of copper in the latter year being 94,404 tons, an increase of 19,386 tons. The increase came mainly from the Mount Isa mine, where the first phase of the long-term expansion programme was completed. In 1959 the mineral industry generally continued at a high level, but some products had to contend with marketing difficulties. The total value of Australian mineral production for 1959, excluding uranium oxide, is expected to be somewhat higher than the 1958 level of £A202,000,000. The demand for most minerals increased during the year and the demand for raw materials is expected to continue at a satisfactory level. While export values for copper, zinc, manganese, zircon, and asbestos increased lead, tungsten, rutile, and silver decreased.

**Tin Plate Research.**—The Broken Hill Proprietary Co., Australia's sole producer of tinplate, has made a grant of £A6,000 per year to support tinplate research by the Commonwealth Scientific and Industrial Research Organisation. The grant will be used to support investigations at the C.S.I.R.O. Division of Food Preservation and Transport, Homebush, New South Wales. The Division is the main centre in Australia for research on tinplate packaging problems. One research project to be undertaken will be a study of the reasons why certain foods, such as canned pears, sometimes cause

intense corrosion of tinplate, a problem which often causes severe losses in the food canning industry. Until 1957, when the B.H.P. opened its new plant at Port Kembla, Australian supplies of tinplate were all imported. Now, however, the Company supplies hot-dipped tinplate for the majority of the food cans manufactured in Australia.

**Constance Range Iron Deposits.**—The Constance Range iron-ore deposit has been under examination by the Broken Hill Proprietary Co., Ltd., for some considerable time. The occurrence, situated in north-west Queensland, 170 miles from Mount Isa, is stated to be very large. According to reports a railway will be required to the coast and a port established, as well as a system of access roads. In the three years the examination has been in progress three airstrips have been built. The proposed railway would cross 60 miles of low-level flats requiring much bridging and raised levels. As the Gulf of Carpentaria is shallow the dredging of deep-water channels will also be important work.

**Airborne Survey.**—A low-level airborne scintillograph survey over country near Kalgoorlie has indicated 13 areas of radioactive variation in which radioactive deposits could occur. These anomalies have been mapped by the Bureau of Mineral Resources.

**Oil.**—Oil search is a major item of interest in the Commonwealth and the gas flows at Roma have directed renewed interest to the possibilities of the utilization of natural gas. The State Electricity Commissioner of Queensland has announced that natural gas will be used in a 12 months' experiment to generate half the power required by the town of Roma and if this trial is successful permanent power generation will be considered. Mines Administration, Ltd., is to pump up to 70,000 cu. ft. of gas per day for the initial test. The Timbury Hills bore produced gas at the rate of 1,250,000 cu. ft. per day. It is anticipated that preparatory work for reticulation of gas will take until the end of the year.

In Western Australia there has been some comment that WAPET (West Australian Petroleum Exploration) may abandon the search following non-success of the hole drilled at Thangoo, near Broome. It has been suggested that the State Government should look into oil exploration. The Minister for Mines has, however, defended Wapet's operations and stated that the company has spent more than £A15,000,000 in the course of its search. The company's work has undoubtedly been well directed and carried out and it would seem that failure to locate oil is likely to be used as a political issue, rather than a matter to be regarded on its merits. It is believed that Wapet will drill another series of holes in the Perth Basin when its seismic survey of the area has been completed.

The South Australian Government has granted to the Australian Pacific Co. Pty., Ltd., which includes overseas companies—Burmah Oil Co. Ltd., and the Murphy Corporation of America—a licence for off-shore drilling. The area covered by the licence extends between the three-mile limit and the 15-mile limit and includes the Fleurieu Peninsula, part of Kangaroo Island, and the sea south of the State to the Victorian border.

Another direction for oil exploration in South Australia is the examination of the Salt Lakes, which are actually extensive salt pans, for oil and possibly other minerals. The surface contains gypsum and salt, but it is hoped that worthwhile deposits of potash and boron may be located. The first drilling objective is Lake Gairdner. Lake Eyre and Lake Torrens will be tested in due course, the work depending on transport conditions for the heavy drilling plant. Another important direction of the work is the geological information on subsurface formations and structure in this arid region.

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## FAR EAST

*August 17.*

**Malayan Tin Industry.**—The secretary of the Perak Chinese Mining Association, Mr. Woo Ka Lim, has issued a statement to the effect that miners must be given more land to work on if Malaya is to maintain her position as the world's biggest tin producer. Many Chinese miners, he said, were now successfully reclaiming land worked a number of years ago and making use of jigs, but they also needed new land. He supported a suggestion made by the All-Malaya Chinese Mining Association that tin prospecting which was stopped because of the emergency should now be resumed.

The Tin Industry Research and Development Board of Malaya spent about (Malayan) $200,000 more than its income last year, it is reported, the extra moneys coming from accumulated and reserve funds. The Malayan Tin Bureau in America used part of the $378,000 spent on publicity in "successfully countering claims that the Federation of Malaya was not adhering to the International Tin Agreement and allegations that the International Tin Council was a cartel." In addition the bureau took part in a campaign to promote "soft drinks in cans" and in stressing that eight out of ten tin cans used in America were made from Malayan tin. The board also contributed $364,000 to research to the Tin Research Institute in England.

**Gold in Kelantan.**—Two gold mines in Kelantan state, Malaya, have started full operation. They are in the Batu Papan district, 9 miles from Gua Musang, once a stronghold of Communists. The mines are jointly operated by Mr. Low Ah Tee and Mr. Lee Cheng Giam, Kota Bharu businessmen. To reach them it is necessary to travel by train from Kota Bharu to Gua Musang, continue for two hours by boat, and then walk for three hours along a jungle trail. Both mines are open-cast, one covering 100 acres, the other 50 acres. The leases were issued before the world war, but because of the Japanese occupation of Malaya and then the emergency operations had to be abandoned. They were recently renewed.

**Indonesia-Japan Pact.**—Indonesia and Japan have signed an agreement on joint exploitation of the oil industry in north Sumatra. Japan is to provide a development loan equal to some £18,800,000 and this will be repaid in shipments of crude oil.

**India.**—The Indian Government has recently been considering the construction of pipelines for the transport of refined petroleum products so as to supplement the capacity of the railways. The foreign exchange cost of building pipelines in India can be much less now that pipes are going to be manufactured by Hindustan Steel, Ltd., at Rourkela.

Mr. K. D. Malaviya, India's Minister for Mines and Oil, said in Bombay that the main aim of his recent trip to Russia was to get instruments and equipment and also to make detailed arrangements for the early production of crude oil.

# Trade Notes

Brief descriptions of developments of interest to the mining engineer

## Dumper Trailer

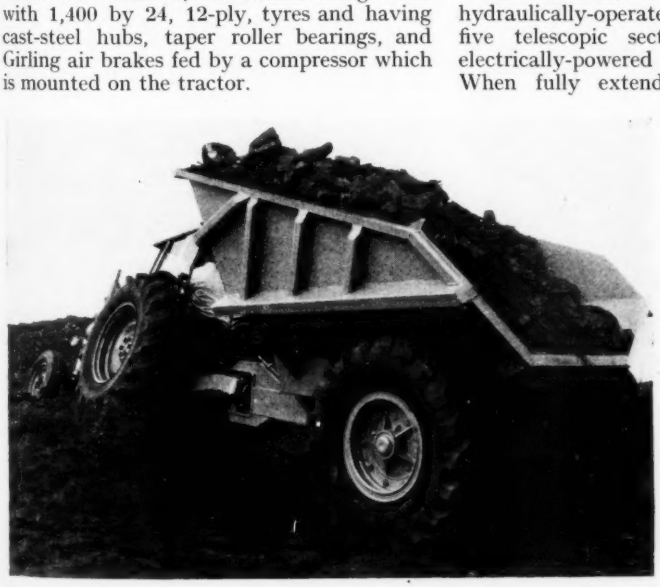
A new hydraulically-operated dumper trailer for use with a Fordson major tractor or similar units has recently been designed by **Robert Hudson, Ltd.,** of Leeds. The machine, which is illustrated here, is known as the Leedsall and is of 7 cu. yd. heaped capacity. It has been designed to give a high all-round performance and has a unique type of draw-bar linkage which permits complete articulation in all directions with a 90° swing in either lock. The draw-bar allows the tractor-trailer combination to articulate within the stability of each unit and gives a turning circle of 30 ft. and its universal coupling makes for compact overall length and wheelbase dimensions and also eliminates excessive torsional stresses when the outfit is under full lock and fully articulated in any plane. The chassis is of heavy-section "A" form construction, formed from 9 in. by 3 in. rolled-steel channel, the wheels being fitted with 1,400 by 24, 12-ply, tyres and having cast-steel hubs, taper roller bearings, and Girling air brakes fed by a compressor which is mounted on the tractor.

## Mobile Roof Scaling Tower

In the May issue of the MAGAZINE was a note about the testing in Derbyshire before engineers of the Russian Trade Delegation of equipment to be supplied by the manufacturers **F. Taylor and Sons (Manchester), Ltd.** Some further specification tests were recently carried out at that company's works at Glazebury in the presence of the U.S.S.R. Trade Delegation headed by their chief technical engineer, Mr. V. Gorbatsevitch, of a new type of mobile roof-scaling tower.

The tower, one of four now in production, forms part of the £250,000 contract for mobile mining equipment secured last autumn and is destined for use in Soviet mines in conjunction with Taylor mobile drilling rigs equipped with Holman drifters. There it will be employed for roof scaling, roof bolting, drilling, and general inspection purposes for mine roofs of up to 90 ft. in height.

The machine consists basically of a hydraulically-operated tower consisting of five telescopic sections mounted on an electrically-powered crawler chassis (Fig. 1). When fully extended (Fig. 2) the tower



**Leedsall Dumper Trailer.**

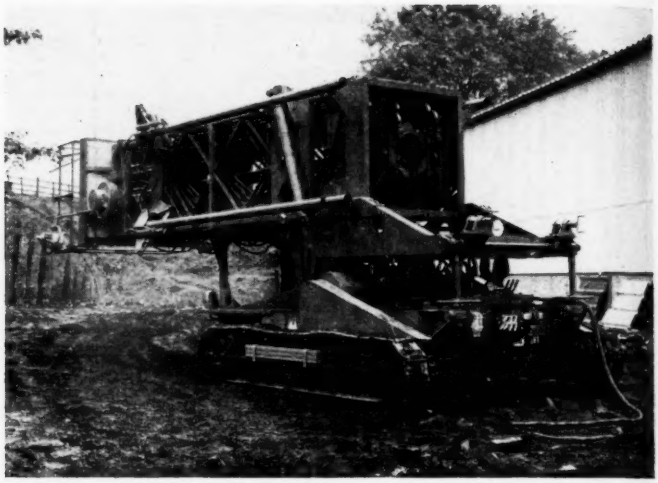


Fig. 1.

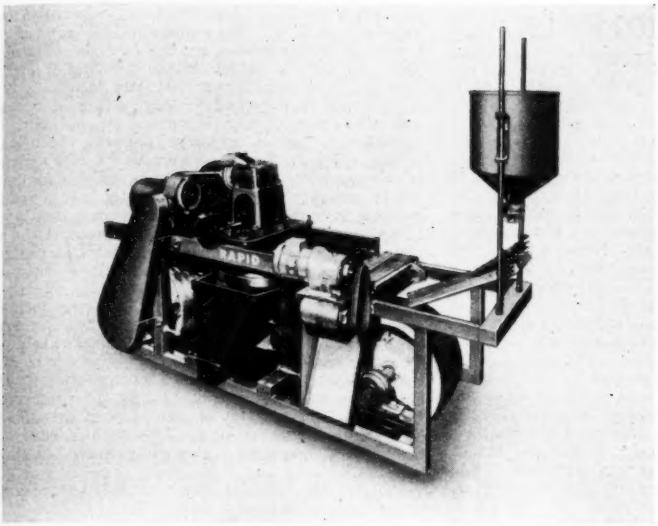
platform achieves a maximum height of 81 ft. and carries a safe working load of 660 lb. For travelling purposes the tower can be retracted and then pivotted through 90° to rest on a sub-frame attached to the chassis. This results in a minimum overall height of 11 ft. 3 in. At the site the telescoped tower sections are raised to the vertical position to rest on a pivoted sub-frame by twin double-acting rams. The outer-tower section is then locked into position by tapered locating pins. At this stage it is necessary to ensure that the tower is vertical. Accordingly the tower chassis is primarily levelled in the lateral plane by slewing on the crawler tracks until the level indicator situated in front of the driver moves to within prescribed limits. The tower is then adjusted longitudinally by means of twin tower-levelling screwjacks attached to the chassis which raise or lower the sub-frame until another level indicator reads correctly. The four support or stabilizing legs are now brought into action. These are fixed to the four top corners of the outer-tower section and are secured alongside the tower when not in use.

Fig. 2.

The tower is now extended by operating a push-button control on the platform which brings into action a double-acting hydraulic ram with a 14-ft. stroke.

Power for all these operations is supplied by a hydraulic pump driven by a $7\frac{1}{2}$-h.p. electric motor.

The chassis is constructed from steel channel members suitably cross-braced and is mounted on crawler tracks inter-connected through a single rocking beam centrally attached. The tower can negotiate a maximum gradient of 1 in 10 and top travelling speed is approximately 1·05 m.p.h. Despite the machine's apparent bulk (26 ft. length and 10 ft. 10 in. width) its weight does




**Rapid Single Disc Separator**

not exceed 12 tons and track pressure is restricted to 1·4 p.s.i. This information is supplied by **Steel and Co., Ltd.,** of Crown Works, Sunderland.

## High-Intensity Magnetic Separator

An addition to their range of magnetic separators has recently been announced by **Rapid Magnetic, Ltd.,** of Lombard Street, Birmingham. This single-disc unit, as illustrated, will treat granular free-flowing minerals—such as, garnet, monazite, ilmenite, wolfram, and columbo-tantalite, and incorporates a magnetic scalper prior to the disc which removes highly-magnetic minerals—such as, magnetite and ferro-silicon—so preventing agglomeration at the disc discharge. By mechanical adjustment of the disc and rheostatic control of magnet current a further two magnetic minerals are separately recovered in one passing and discharged on either side of the separator belt. Clean non-magnetics are discharged at the conveyor head. Feed is by gravity from a hopper; alternatively a vibratory unit is available. Capacity is dependent on the characteristics of the material and degree of separation required. The company undertake to carry out preliminary tests on representative samples.

# Personal

R. B. ANDREW is leaving Malaya for Australia.

A. A. BAKEWELL is now in Cyprus.

DAVID A. BANCEL has been appointed vice-president in charge of purchasing of Cerro de Pasco Sales Corporation.

A. A. G. BOWERMAN is now in Tanganyika.

M. CLESHAM is now sales manager with the Libu Shovel Co. (Great Britain), Ltd.

LLOYD E. ELKINS, a 1934 graduate of the Colorado School of Mines, has been nominated president-elect of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

G. S. INNS is leaving for the Philippines.

T. O. MARTYN is home from India.

J. N. MUNRO has left New Zealand for Fiji.

R. N. PRYOR is returning from Spain.

W. PULFREY has left for Kenya.

JAMES E. QUINN has been appointed general sales manager for the Denver Equipment Company.

D. H. P. ROWE has left for India after sick leave in the United Kingdom.

C. T. SWEET is home from the Republic of Guinea.

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STANKO MIHOLIČ, Professor of Geochemistry in the University of Zagreb, died as a result of a heart attack during one of the International Geological Congress excursions to arctic Norway. Dr. Miholič specialized for many years in geochemical studies of radioactive and other spring waters in Yugoslavia and his latest paper, on the Secondary Enrichment of Uranium in Sediments, was due to be read at the meetings in Copenhagen. His distinguished work is widely known throughout Western Europe and America, in part as a result of his occasional attendance at international conferences at which he made many warm friendships.

# Metal Markets

## During August [1]

**Copper.**—The broad picture in August is of a month in which the basic considerations of supply and demand exerted a greater influence on market sentiment and prices than various short-term developments of a bullish nature.[2] As the month ended only one of such developments was left to trouble the market—namely, fears of a strike at the Chuquicamata mine in Chile. The miners have submitted extreme wage claims which the company says it cannot possibly meet. Hopes of a strike being averted when the present wage contract falls due for renewal at the end of September now rest on the commonsense point of view that the Chilean Government cannot afford a stoppage in so important a foreign currency earning industry and will take all steps to avoid strife.

The other points that gave rise to intermittent revivals both in confidence and in prices were the Congo position and the analogous possibility of racial trouble in Rhodesia. Despite the unsatisfactory nature of the general political position in the Congo, it is now reliably reported that it has been possible to restore copper output there to normal levels prevailing prior to independence and moreover to ship the metal to the market. This does not mean that the Congo chapter is completely closed, but at any rate for the time being it is not a major market factor. In Rhodesia a new wage agreement between the companies and the African Mineworkers' Union was reached in August; this gives the African workers a 15s. per "ticket" increase, as well as consolidating earlier cost of living advances. The present agreement lasts until the end of next year.

Highlighting the reverse side of the picture—the excess of supplies over demand—were the figures of the U.S. Copper Institute for July, which became available this month. They show that while the consumption position outside the U.S.A. remains satisfactory, although fractionally below the high rate of the early part of the year, that inside the U.S.A. is extremely dismal. Fabricators' deliveries of products in July were the lowest in eleven years. Already, therefore, there is a noticeable resumption of talk on the lines heard in the early summer, to the effect that major suppliers must be not only willing but determined to restrict output—and in good time—if the market is not to turn seriously weaker. A side reflection of the easier supply position is that stocks in London Metal Exchange warehouses have shown a rising trend in recent weeks.

Consumption of copper in the U.K. in June was 65,398 tons, bringing the half-year to 374,620 tons against 306,424 tons in first-half 1959—no bad feat. Of the June total 54,830 tons was refined and 287,337 tons of the half-year figure. Production of primary refined was 10,464 tons and of secondary refined 8,611 tons; stocks of refined copper dropped from 63,832 tons to 56,257 tons, but stocks of blister rose from 13,976 tons to 15,134 tons.

**Tin.**—In August the International Tin Council held a meeting to fix fourth quarter quotas; in the communique following it was revealed no export restriction would be imposed. This means that for the first time in almost three years the market is free to move without interference in response to the influences of supply and demand. This freedom, of course, is circumscribed by the *tranches* £780 and £830 per ton at which levels the Buffer Stock manager may respectively buy and sell.

The market expected no diminution in quotas and the decision was therefore not a startling variation from the unchanged quotas which had been predicted. Since the current quarter's quota is at least 95% of pre-quota exports full freedom would, at the best of times, mean only a small increase in supplies. Since certain producers have fallen significantly short of their quota lately it might be argued the effective supply to the market next quarter might be the same as in the current one. The differing factor is mine stocks, which may now be freely exported. What with underproduction and barter deals, however, only Malaya has any sizeable stocks and it is believed these are likely to be marketed carefully during the currency of the fourth quarter. Over-enthusiastic marketing would only drive the price down against the producers. In any case quite a lot of these stocks are still in concentrates, the smelting of which cannot be undertaken overnight. For the moment stability prevails.[1]

U.K. June consumption was 2,133 tons and production 2,828 tons. Stocks rose to 11,113 tons.

**Lead.**—Briefly the lead position remains unhealthy. Despite supply restrictions, maintenance of which for another six months is expected to be confirmed at the Lead-Zinc Conference in Geneva next month, prices in London have kept very close to the £70 per ton mark and sentiment remains depressed.[1] Consumption in the U.K. is very fair and elsewhere, outside the U.S.A., quite adequate. It is the U.S. position which is the depressant. It is therefore beneficial that it is not expected that any legal action can be taken this year to raise U.S. tariffs or extend the influence of quotas.

U.K. June consumption was 33,318 tons, bringing the half-year to 191,977 tons, some 23,000 tons better than in 1959. June output was 7,378 tons, while stock remained unchanged overall at 46,542 tons.

**Zinc.**—With some mutterings about lessened activity in the U.K. motor-car industry lately zinc has tended to look a shade less assured.[1] On the whole, however, the position is quite good and one can foresee lead and zinc producers relying more on the latter metal than the former as a profit-earner for a little while yet. In contrast to the metal concentrates are in keen demand and the position may well strengthen as time passes. More concentrates are being treated nearer the mine nowadays. In the U.S.A. the statistical position is still unsatisfactory. Despite the use of galvanized steel for the new "compact" cars zinc use remains down there.

U.K. June use was 33,058 tons, output 6,109 tons, and stocks slightly down at 52,004 tons.

**Iron and Steel.**—With the holiday season August is always a fairly quiet month for the steel industry and production is well below the June level. (Output in July is also affected by the holidays.) Now that the holiday interruptions are over it appears that demand for steel is broadly maintained and the works enter the final part of the year with good order books and a steady arrival of new business. There is confidence that the industry's "target"

[1] Recent prices, pp. 136, 176.
[2] See Table, p. 176.

[1] See Table, p. 176.

of 24,000,000 ingot tons will be reached, which will make 1960 the best year ever for the U.K. steel industry.

The current strength of steel is based firmly on a need for material for immediate consumption, but nevertheless many consumers have now begun to build up their depleted stocks. At the end of the second quarter stocks of finished steel rose by 8%, or 270,000 tons, over the first quarter which was the largest recorded quarterly increase. This followed an increase in the first quarter of 175,000 tons.

There was a big rise in sheet stocks in the second quarter, made possible by heavy imports, but the motor industry continues to consume large quantities of steel, particularly autobody sheets. Some observers believe, however, that the industry's peak may have been reached. Already there are signs that car output is beginning to decline; one important factor is the success of the new compact cars in the United States, which are making inroads into the foreign-produced small-car market. Stiffer credit restrictions in Britain are affecting home sales of cars. However, a fall in demand from the motor industry will not have such a severe effect upon the steel industry as it would if it had occurred a year ago. To-day there is a good level of demand from a wider range of British industry. The heavy end of the trade, like the makers of lighter grades of steel products, is being hard pressed to meet consumers' requirements and considerable delivery delays exist. There are, however, still a few exceptions: the producers of railway material and colliery equipments are still working below capacity.

Exports of British iron and steel have declined from the peak reached in October last year, while on the other hand there has been a sharp rise in imports of iron and steel. Arrivals of foreign sheets amounted to no less than 447,000 tons in the first seven months of this year.

**Iron Ore.**—The large intake of imported iron ores continues and the extraction of domestic ores has been maintained at a high level. Imports in the first seven months of the year increased to 10,100,000 tons, a rise of more than 3,300,000 tons over the same period of 1959, and home ore production in the first half of 1960 averaged 326,800 tons a week, as compared with 283,400 tons a week in the first half of last year.

**Aluminium.**—Interest in aluminium in August has centred on Australia. Following recent progress towards planning a major industry in Australasia, based on Queensland bauxite, by Commonwealth Aluminium Co., and big fabricating plans by two major groups, the August news that the Bell Bay smelter was to be sold by the Government to the Tasmanian Government (one-third) and the Consolidated Zinc Corporation (two-thirds) was received with keen interest. An immediately noticeable benefit arising out of the change is that plans for expanding capacity to 28,000 tons a year are to be put in hand without delay. It is hoped that in four years this level will be attained and metal produced economically at world prices. Bell Bay hitherto has, frankly, not been an economic proposition.

In other parts of the world there is a different tale to tell. In East Africa earlier plans to establish a sizeable rolling mill by the Canadian Aluminium, Limited, group have been shelved. Initial reaction was that this was partly due to political factors, but subsequently it has been appreciated that, in relation to the size of the potential market, a local mill was not an economic proposition as compared with importing from one of the low-cost European strip mills. This group was also in the news for announcing a new process for producing aluminium. While opinions are guesswork it is widely felt that the process envisages distillation of aluminium from a halide of the metal (probably trichloride) made direct from bauxite. Actual operating costs may not be much reduced but capital costs would be very much lower.

**Antimony.**—Despite the continued availability of Russian and Chinese antimony regulus in many important consuming markets of the world material produced in Western Europe continues to sell freely. This is explained in large part by the continued good figures for U.K. consumption of new antimony, which are about 700 tons up in the first half of 1960 compared with the same period of 1959. As a result of this activity demand for antimony ore has also kept at a keen level, the keenness sharpened by regular Japanese intervention in this market.

During August antimony ore buying prices in the U.K. advanced by 1s. per unit of metal to come more closely into line with world trends; 50% to 55% sulphide ore is now indicated at 20s. to 21s. per unit and 60% at 21s. to 22s. Meanwhile there has been no change in regulus prices, U.K. 99% remaining at £190 per ton and 99·6% at £197 10s.

**Arsenic.**—There is very little activity in arsenic metal these days and U.K. prices are more or less nominally maintained at £400 per ton. The trioxide, too, is much less active than it was; prices keep in the range £40 to £45 per ton.

**Bismuth.**—Growing numbers of people are taking an interest in bismuth for prospective electronic and thermo-electric uses, especially as bismuth telluride. Another U.K. firm has been added to the list of suppliers in the past month. Prices are held steadily as ever at 16s. per lb.

**Cobalt.**—A lot of people are still trying to get excited about cobalt, so much of the world's supplies of which come from the Congo. However, with copper output there reported as back to normal it seems a fair assumption that cobalt supplies are, currently, not far behind. All the same new supplies are eagerly canvassed by both consumers and merchants. A disappointment in this respect is the Moa Bay plant in Cuba of Freeport Nickel, which but for seizure by the revolutionary Government there might now have been feeding a cobalt acceptable for European consumption. Increased supplies from Canada and New Caledonia are possible, but as long as the Congo accounts for half the world's supplies or more anxiety is likely to remain. It is well that there is no sign of prices shifting from the level of 10s. 9d. per lb. delivered to contract consumers.

**Cadmium.**—Consumption of cadmium keeps up at a good rate in Europe; there is no surplus and supplies drawn from Congo raw materials may have diminished. So far this has been offset by metal fairly freely available from the U.S.A., where the statistical position is not so propitious as over here. U.K. prices remain based on 10s. 6d. per lb. delivered.

**Chromium.**—Chromium is mostly used in plating as a salt. However, it is pertinent to note under this heading that a recently introduced scheme to boost the quality of plated goods in the U.K., and recommend chromium plating to users generally, seems to be gaining a satisfactory acceptance in the trade. Metal is still indicated at 6s. 11d. to 7s. 4d. per lb.

**Tantalum.**—Tantalum ore is in an interesting position. According to the purpose for which they require it different users feel differently about the price they will pay for ore and the grade they favour. For the moment the ruling indication for 60% material is 700s. to 750s. per unit.

**Platinum.**—This has been a conspicuously dull month in the platinum metals generally. As far as platinum is concerned the reserve of buyers is only matched by the apathy of sellers. The major suppliers are still quite happy at £30 5s. per troy oz. and sell adequate quantities of metal at this level. Such parcels as have changed hands in the free market have remained between £28 5s. and £28 15s. per oz.

**Iridium.**—"Free" iridium has sagged even further in the quiet conditions of the past month and the metal price is now indicated at £20 to £26 15s. per troy oz.

**Palladium.**—Prices of this metal have held at those last indicated in a dull market—*i.e.*, at £8 10s. to £9 7s. 6d. per troy oz.

**Osmium.**—Ever the dullest of the platinum metals (from a market point of view) osmium has been most inactive in August. Prices are slightly worse at £18 to £25 per troy oz.

**Tellurium.**—Tellurium has not been so much in the limelight in August, but it can be assumed that long-term supply considerations have continued to engage those most closely concerned with the metal. Prices for lump and powder remain 25s. per lb. and for sticks some 40s. per lb.

**Tungsten.**—Tungsten ore has also been rather indeterminate in August; activity has been about average for a holiday month. All circumstances considered the market has stood up quite well in the face of one noteworthy parcel of material—believed again to be Russian—being sold at a conspicuously low price. End users of the ore are enjoying quite active conditions, but tempered to a certain extent by holiday considerations. Prices have held within a narrow range, the August closing quotation being 155s. to 161s. per long ton unit c.i.f.

**Nickel.**—Nickel users are now beginning to look forward to next year when production from the International Nickel Co's. new Manitoba property commences. For the past 18 months a nickel surplus has been in sight. Now that booming consumption looks like making the statistics nearer balance users look comfortably ahead to another heavy surplus shortly. Prices remain at £600 per ton.

**Chrome Ore.**—Chrome ore has continued to flow into consumption at a very fair rate in the past month bearing holidays in mind. With the wet summer there has been less of a bottleneck at the ferrochrome stage in Europe than was at one time feared. As a result, the ferro-alloy is not in seriously short supply. However, so far users have not given any indication of their interest in 1961 supplies, but this may be expected to follow in due course. Rhodesian metallurgical ore is still indicated c.i.f. at £15 5s. per ton.

**Molybdenite.**—Following July's alarms and excursions molybdenite has returned to an even keel in August. Consumption continues at a high rate. Prices remain 8s. 11d. per lb. Mo f.o.b. mine.

**Manganese Ore.**—Manganese ore has remained featureless from a market point of view in August, although fair tonnages of material have continued to go into consumption. Although the Indian market is kept busy supplying material under the big barter deal ore is still offered from there at low prices. For the present, however, a reliable market indication remains 68d. to 72d. per unit.

## Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98% per ton.

| Date | Tin | | Copper | | Lead | | Zinc | |
|---|---|---|---|---|---|---|---|---|
| | Settlement | 3 Months | Spot | 3 Months | Spot | 3 Months | Spot | 3 Months |
| | £ s. | £ s. | £ s. | £ s. | £ s. | £ s. | £ s. | £ s. |
| Aug. 11 | 804 0 | 805 15 | 245 2½ | 244 17½ | 70 1¼ | 70 18¾ | 88 8¾ | 88 11¼ |
| 12 | 803 0 | 804 5 | 245 2½ | 244 12½ | 70 1¼ | 71 1¼ | 88 1¼ | 88 8¼ |
| 15 | 797 0 | 798 10 | 241 17½ | 242 7½ | 69 18¾ | 70 18¾ | 86 18¾ | 87 18¾ |
| 16 | 796 10 | 798 5 | 242 2½ | 241 15 | 71 3¾ | 71 11¼ | 87 7½ | 88 2½ |
| 17 | 794 0 | 797 10 | 243 12½ | 243 2½ | 71 5 | 71 12½ | 87 2½ | 87 10 |
| 18 | 794 0 | 797 10 | 245 12½ | 244 2½ | 71 12½ | 71 18¾ | 87 8¾ | 87 8¼ |
| 19 | 791 10 | 794 5 | 247 7½ | 245 12½ | 71 18¾ | 72 1¼ | 87 6¼ | 87 3¾ |
| 22 | 793 10 | 795 15 | 242 2½ | 241 7½ | 71 8¾ | 71 11¼ | 86 11¼ | 86 18¾ |
| 23 | 802 0 | 804 10 | 243 17½ | 242 15 | 71 11¼ | 71 12½ | 86 2½ | 86 2½ |
| 24 | 801 0 | 803 0 | 242 7½ | 241 12½ | 70 17½ | 71 1¼ | 85 13¾ | 85 12½ |
| 25 | 804 10 | 802 15 | 241 17½ | 241 5 | 70 16¼ | 71 1¼ | 85 10 | 85 13¾ |
| 26 | 796 0 | 797 10 | 241 7½ | 241 7½ | 70 17½ | 71 3¾ | 86 1¼ | 86 1½ |
| 29 | 802 0 | 802 10 | 239 2½ | 239 17½ | 71 6¼ | 71 11¼ | 86 3¾ | 86 8¾ |
| 30 | 800 0 | 800 15 | 238 2½ | 238 7½ | 71 6¼ | 71 11¼ | 85 17½ | 86 3¾ |
| 31 | 800 0 | 800 10 | 235 12½ | 236 2½ | 71 8¾ | 71 11¼ | 86 1¼ | 86 3¾ |
| Sept. 1 | 803 0 | 802 15 | 234 2½ | 234 7½ | 71 1¼ | 71 3¾ | 85 17½ | 85 17½ |
| 2 | 804 10 | 803 15 | 235 12½ | 235 12½ | 70 7½ | 70 13¾ | 85 13¾ | 85 13¾ |
| 5 | 802 0 | 801 15 | 235 2½ | 234 17½ | 70 6¼ | 70 13¾ | 85 16¼ | 85 17½ |
| 6 | 801 10 | 801 15 | 234 12½ | 235 2½ | 70 3¾ | 70 12½ | 85 16¼ | 85 17½ |
| 7 | 801 0 | 800 5 | 236 2½ | 236 2½ | 70 17½ | 70 17½ | 86 5 | 86 3¾ |
| 8 | 800 10 | 799 5 | 236 2½ | 236 2½ | 70 6¼ | 70 11¼ | 86 10 | 86 10 |
| 9 | — | — | — | — | — | — | — | — |

# Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

| | July | | August | |
|---|---|---|---|---|
| | Treated Tons | Yield Oz.† | Treated Tons | Yield Oz.* |
| Blyvooruitzicht | 133,000 | 86,519 | 138,000 | 89,706 |
| Brakpan | 146,000 | 17,539 | 146,000 | 17,558 |
| Buffelsfontein‡ | 148,000 | 60,273 | 145,000 | 59,979 |
| City Deep | 119,000 | 23,391 | 119,000 | 23,723 |
| Cons. Main Reef | 62,000 | 12,028 | 59,000 | 11,635 |
| Crown Mines | 207,000 | 34,971 | 206,000 | 35,129 |
| Daggafontein | 233,000 | 47,217 | 230,000 | 46,575 |
| Dominion Reef | 43,500 | 290 | 39,300 | 479 |
| Doornfontein‡ | 105,000 | 42,620 | 105,000 | 43,302 |
| D'rb'n Roodeport Deep | 198,000 | 36,016 | 198,000 | 36,186 |
| East Champ D'Or‡ | 12,000 | 330 | 12,000 | 334 |
| East Daggafontein | 106,000 | 18,026 | 107,000 | 18,190 |
| East Geduld | 129,000 | 37,440 | 134,000 | 38,525 |
| East Rand P.M. | 234,000 | 53,515 | 235,000 | 54,457 |
| Eastern Transvaal Consol | 19,100 | 6,154 | 19,200 | 6,174 |
| Ellaton‡ | 29,000 | 6,847 | 28,000 | 6,615 |
| Freddies Consol. | 64,000 | 13,726 | 64,000 | 13,711 |
| Free State Geduld | 96,000 | 82,641 | 95,000 | 82,100 |
| Geduld | 75,000 | 12,527 | 78,000 | 12,675 |
| Government G.M. Areas‡ | 52,000 | 10,753 | 54,000 | 11,008 |
| Grootvlei Proprietary | 219,000 | 45,443 | 227,000 | 46,992 |
| Harmony Gold Mining | 167,000 | 66,830 | 173,000 | 69,263 |
| Hartebeestfontein‡ | 120,000 | 55,796 | 120,000 | 55,802 |
| Libanon | 117,000 | 27,910 | 117,000 | 27,960 |
| Loraine | 81,000 | 17,217 | 82,000 | 17,429 |
| Luipaards Vlei‡ | 120,000 | 13,579 | 120,000 | 13,513 |
| Marievale Consolidated | 99,000 | 24,180 | 101,000 | 24,594 |
| Modderfontein East | 125,000 | 12,834 | 138,000 | 12,972 |
| New Kleinfontein | 77,000 | 9,891 | 77,000 | 10,467 |
| New Klerksdorp‡ | 11,000 | 1,042 | 9,700 | 1,011 |
| President Brand | 118,000 | 95,590 | 118,000 | 95,643 |
| President Steyn | 100,000 | 37,311 | 103,000 | 38,401 |
| Rand Leases | 192,000 | 28,032 | 196,000 | 28,126 |
| Randfontein‡ | 173,000 | 13,272 | 168,000 | 13,221 |
| Rietfontein Consolid't'd. | 15,000 | 4,060 | 15,000 | 3,985 |
| Robinson Deep | 43,500 | 10,155 | 43,000 | 9,978 |
| Rose Deep | 23,000 | 4,190 | 23,000 | 4,496 |
| St. Helena Gold Mines | 167,000 | 56,782 | 179,000 | 62,207 |
| Simmer and Jack | 75,000 | 13,430 | 75,000 | 13,310 |
| S. African Land and Ex. | 98,500 | 20,452 | 101,000 | 20,957 |
| S. Roodepoort M.R. | 30,000 | 7,213 | 31,000 | 7,391 |
| Spaarwater Gold | 11,000 | 3,429 | 11,000 | 3,431 |
| Springs | 102,000 | 14,091 | 98,000 | 13,668 |
| Stilfontein Gold Mining‡ | 168,000 | 75,936 | 168,000 | 76,300 |
| Sub Nigel | 66,500 | 15,079 | 66,500 | 15,282 |
| Transvaal G.M. Estates | 7,300 | 1,966 | 7,300 | 2,075 |
| Vaal Reefs‡ | 105,000 | 47,251 | 103,500 | 46,575 |
| Van Dyk Consolidated | 75,000 | 11,821 | 78,000 | 12,479 |
| Venterspost Gold | 123,000 | 34,133 | 125,000 | 34,981 |
| Village Main Reef | 32,000 | 4,720 | 29,500 | 4,336 |
| Virginia O.F.S.‡ | 136,000 | 28,579 | 56,000 | 11,766 |
| Vlakfontein | 52,000 | 18,858 | 52,000 | 18,828 |
| Vogelstruisbult‡ | 85,000 | 18,330 | 85,000 | 18,343 |
| Welkom Gold Mining | 102,000 | 32,148 | 100,000 | 31,781 |
| West Driefontein‡ | 130,000 | 120,836 | 130,000 | 121,506 |
| West Rand Consol.‡ | 216,000 | 22,005 | 213,000 | 21,550 |
| Western Holdings | 157,000 | 104,436 | 157,000 | 104,251 |
| Western Reefs | 143,500 | 40,611 | 143,500 | 40,683 |
| Winkelhaak | 93,000 | 30,225 | 95,000 | 31,351 |
| Witwatersrand Nigel | 20,000 | 4,430 | 20,000 | 4,438 |

† 249s. 5d. * 249s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

| | Tons milled | Yield per ton | Work'g cost per ton | Work'g profit per ton | Total working profit |
|---|---|---|---|---|---|
| | | s. d. | s. d. | s. d. | £ |
| Sept. 1959 | 18,214,200 | 70 5 | 45 2 | 25 3 | 30,140,529 |
| Oct. | — | — | — | — | — |
| Nov. | — | — | — | — | — |
| Dec. | 17,670,000 | 72 2 | 45 10 | 26 4 | 30,559,937 |
| Jan., 1960 | — | — | — | — | — |
| Feb. | — | — | — | — | — |
| Mar. | 17,464,400 | 72 8 | 46 5 | 26 3 | 30,105,571 |
| April | — | — | — | — | — |
| May | — | — | — | — | — |
| June | 17,968,300 | 73 9 | 46 3 | 27 6 | 31,941,743 |
| July | — | — | — | — | — |
| August | — | — | — | — | — |
| Sept. | — | — | — | — | — |

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

| | Rand and O.F.S. | Outside | Total |
|---|---|---|---|
| | Oz. | Oz. | Oz. |
| August, 1959 | 1,699,098 | 36,052 | 1,735,150 |
| September | 1,701,485 | 36,567 | 1,738,052 |
| October | 1,718,916 | 33,576 | 1,752,492 |
| November | 1,688,379 | 34,903 | 1,723,282 |
| December | 1,662,043 | 31,309 | 1,693,352 |
| January, 1960 | 1,701,110 | 34,651 | 1,735,761 |
| February | 1,675,248 | 38,859 | 1,714,107 |
| March | 1,664,514 | 38,744 | 1,703,258 |
| April | 1,734,310 | 36,720 | 1,771,030 |
| May | 1,765,880 | 37,897 | 1,803,777 |
| June | 1,775,335 | 37,530 | 1,812,865 |
| July | 1,776,141 | 39,673 | 1,815,814 |

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

| | Gold Mines | Coal Mines | Total |
|---|---|---|---|
| November 30, 1959 | 358,746 | 32,067 | 390,813 |
| December 31 | 354,058 | 31,963 | 386,021 |
| January 31, 1960 | 372,254 | 31,993 | 404,247 |
| February 29 | 385,027 | 32,144 | 417,171 |
| March 31 | 388,800 | 30,696 | 419,556 |
| April 30 | 385,841 | — | — |
| May 31 | 383,212 | 30,933 | 414,145 |
| June 30 | 380,593 | 31,435 | 412,028 |
| July 31 | 378,626 | 31,879 | 410,505 |

MISCELLANEOUS METAL OUTPUTS

| | 4-Week Period To Aug. 20 | | |
|---|---|---|---|
| | Tons Ore | Lead Concs. tons | Zinc Concs. tons |
| Broken Hill South | — | — | — |
| Electrolytic Zinc | 19,456 | 1,010 | 5,052 |
| Lake George | 16,702 | 1,297 | 2,624 |
| Mount Isa Mines** | 64,337 | 4,100† | 4,141 |
| New Broken Hill | 31,840 | 3,149 | 6,504 |
| North Broken Hill | 34,707 | 6,699 | 7,219 |
| Zinc Corp. | 33,020 | 4,323 | 6,570 |
| Rhodesia Broken Hill* | — | — | — |

* 3 Months, ** Copper 3,600 tons blister; 9,725 tons concs.; † Metal.

RHODESIAN GOLD OUTPUTS

| | July | | August | |
|---|---|---|---|---|
| | Tons | Oz. | Tons | Oz. |
| Cam and Motor | — | — | — | — |
| Falcon Mines | 21,000 | 4,069 | 21,000 | 4,084 |
| Globe and Phœnix | 6,100 | 3,087 | 6,000 | 2,898 |
| Motapa Gold Mining | — | — | — | — |
| Mazoe | 3,220 | — | 2,899 | — |
| Coronation Syndicate | 11,936 | — | 12,034 | — |
| Phœnix Prince* | — | — | — | — |

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

| | July | | August | |
|---|---|---|---|---|
| | Tons | Oz. | Tons | Oz. |
| Amalgamated Banket | 54,204 | 12,251 | 54,105 | 12,625 |
| Ariston Gold Mines | 39,000 | 11,567 | 39,480 | 11,498 |
| Ashanti Goldfields | 36,500 | 29,500 | 36,500 | 29,500 |
| Bibiani | 33,000 | 6,900 | 33,000 | 7,200 |
| Bremang | — | 4,813 | — | 4,375 |
| Ghana Main Reef | 10,766 | 4,230 | 12,376 | 4,189 |
| Konongo | 7,230 | 3,375 | 7,210 | 3,421 |
| Lyndhurst | — | — | — | — |

## PRODUCTION OF GOLD AND SILVER IN RHODESIA

| | 1959 | | 1960 | |
|---|---|---|---|---|
| | Gold (oz.) | Silver (oz.) | Gold (oz.) | Silver (oz.) |
| January | 46,489 | 18,077 | 44,902 | 29,711 |
| February | 43,366 | 19,806 | 45,754 | 29,865 |
| March | 48,397 | 17,394 | 45,309 | 29,656 |
| April | 46,315 | 5,694 | 48,607 | 6,847 |
| May | 46,423 | 46,280 | 47,542 | 62,912 |
| June | 49,995 | 31,386 | — | — |
| July | 46,512 | 32,734 | — | — |
| August | 38,727 | 29,178 | — | — |
| September | 56,760 | 33,837 | — | — |
| October | 48,528 | 32,314 | — | — |
| November | 47,916 | 31,092 | — | — |
| December | 47,452 | 31,175 | — | — |

## WESTRALIAN GOLD PRODUCTION

| | 1958 | 1959 | 1960 |
|---|---|---|---|
| | Oz. | Oz. | Oz. |
| January | 66,562 | 63,924 | 64,794 |
| February | 65,965 | 65,035 | 66,789 |
| March | 65,420 | 65,408 | 61,941 |
| April | 60,855 | 62,686 | 65,373 |
| May | 64,196 | 64,184 | 66,682 |
| June | 67,929 | 74,590 | 74,902 |
| July | 81,106 | 78,974 | 67,623 |
| August | 68,610 | — | — |
| September | 68,744 | — | — |
| October | 70,128 | 70,427 | — |
| November | 67,562 | 68,858 | — |
| December | 120,106 | 117,474 | — |
| Total | 867,187 | 861,122 | — |

## AUSTRALIAN GOLD OUTPUTS

| | 4-Week Period | | | |
|---|---|---|---|---|
| | To July 19 | | To Aug. 16 | |
| | Tons | Oz. | Tons | Oz. |
| Central Norseman | 13,670 | 6,813 | 14,048 | 7,560 |
| Gold Mines of Kalgoorlie | 41,073 | 10,657 | 40,710 | 10,686 |
| Gt. Boulder Gold Mines* | — | — | — | — |
| Gt. Western Consolidated | 31,325 | 5,053 | 33,550 | 5,128 |
| Lake View and Star* | — | — | — | — |
| North Kalgurli | 28,718 | 6,312 | — | — |
| Sons of Gwalia | 11,624 | 2,579 | 12,502 | 2,533 |
| Mount Morgan | — | 4,502 | — | 4,134 |

* 3 Months.

## ONTARIO GOLD AND SILVER OUTPUT

| | Tons Milled | Gold Oz. | Silver Oz. | Value Canad'n $ |
|---|---|---|---|---|
| March, 1959 | 807,952 | 223,728 | 33,045 | 7,616,425 |
| April | 776,583 | 225,027 | 32,778 | 7,712,425 |
| May | 791,199 | 227,924 | 34,006 | 7,713,970 |
| June | 768,725 | 213,486 | 31,692 | 7,178,823 |
| July | 774,749 | 221,814 | 32,172 | 7,498,030 |
| August | 683,819 | 191,598 | 29,141 | 6,428,545 |
| September | 754,208 | 213,772 | 34,139 | 7,116,556 |
| October | 794,030 | 227,192 | 34,733 | 7,558,567 |
| November | 770,437 | 227,176 | 35,262 | 7,600,949 |
| December | 775,803 | 221,377 | 40,807 | 7,388,654 |
| January, 1960 | 778,103 | 226,856 | 27,617 | 7,550,068 |
| February | 755,569 | 222,484 | 35,003 | 7,446,848 |
| March | 804,309 | 229,457 | 37,202 | 7,646,044 |
| April | 779,487 | 218,393 | 42,997 | 7,426,262 |
| May | 784,391 | 225,550 | 32,174 | 7,765,153 |
| June | 791,488 | 223,833 | 49,765 | 7,756,490 |

## MISCELLANEOUS GOLD AND SILVER OUTPUTS

| | July | | August | |
|---|---|---|---|---|
| | Tons | Oz. | Tons | Oz. |
| Clutha River | — | 646 | — | 665 |
| Lampa (Peru)† | — | 41,630 | — | — |
| New Guinea Goldfields | 4,507 | 1,427 | — | — |
| Yukon Consol. | — | $430,000 | — | — |

† Oz. Silver : Copper, 136 tons ; 108 tons.

## AUSTRALIAN BASE-METAL OUTPUTS

| Period | Concentrate Production (Long Tons) | | |
|---|---|---|---|
| | Zinc | Copper (a) | Lead |
| 1959 | 246,693 | 89,162 | 305,163 |
| Provisional | | | |
| 1959—January | 12,946 | 7,744 | 14,874 |
| February | 23,658 | 8,493 | 26,361 |
| March | 27,377 | 9,776 | 30,402 |
| April | 82,992 | 8,142 | 23,477 |
| May | 25,122 | 9,400 | 26,832 |
| June | — | — | — |
| July | — | — | — |
| August | — | — | — |
| September | — | — | — |
| October | — | — | — |
| November | — | — | — |
| December | — | — | — |

(a) includes Cu content of direct smelting ore.

## OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

| | June | July | Aug. |
|---|---|---|---|
| Ampat Tin | 60 | 59½ | 70 |
| Austral Amalgamated | — | — | — |
| Ayer Hitam | 703* | — | — |
| Batu Selangor | — | — | — |
| Berjuntai | 149 | 218½ | 272½ |
| Chenderiang | 58* | — | — |
| Gopeng Consolidated | 383* | — | — |
| Hongkong Tin | 85* | — | — |
| Idris Hydraulic | 71* | — | — |
| Ipoh | 131* | — | — |
| Jelapang Tin | — | — | — |
| Kampong Lanjut | 110 | 123 | 171 |
| Kamunting | 138 | 139 | 139 |
| Kent (F.M.S.) | 65* | — | — |
| Kepong | — | — | — |
| Killinghall | 128½* | — | — |
| Kinta Kellas | 18 | 33 | 25 |
| Kinta Tin Mines | — | — | — |
| Klang River | — | — | — |
| Kramat | 44 | 59 | 61 |
| Kuala Kampar | 164 | 133 | 96 |
| Kuala Lumpur | — | — | — |
| Kuchai | — | — | — |
| Lahat Mines | — | — | — |
| Larut | — | 10 | 17½ |
| Lower Perak | 114 | 160 | 160½ |
| Malayan | 1,129* | — | — |
| Malaysiam | 9½ | — | — |
| Pacific Tin Consolidated | — | — | — |
| Pahang Consolidated | 681* | — | — |
| Pengkalen | 104* | — | — |
| Petaling Tin | 261* | — | — |
| Puket | — | — | — |
| Rahman Hydraulic | — | — | — |
| Rambutan | 31* | — | — |
| Rantau | 61½ | 65½ | 62½ |
| Rawang Concessions | — | — | — |
| Rawang Tin Fields | — | — | — |
| Renong | — | — | — |
| Selayang | 46* | — | — |
| Siamese Tin Syndicate (Malaya) | 31 | 35 | 33 |
| Southern Kinta | 337 | 324 | 278 |
| Southern Malayan | 859½* | — | — |
| Southern Tronoh | — | — | — |
| Sungei Besi | 372½* | — | — |
| Sungei Kinta | — | — | — |
| Sungei Way | 367½* | — | — |
| Taiping Consolidated | — | — | — |
| Tambah | — | — | — |
| Tanjong | 162* | — | — |
| Tekka | — | — | — |
| Tekka-Taiping | — | — | — |
| Temoh | 5½* | — | — |
| Tongkah Compound | — | — | — |
| Tongkah Harbour | 202 | 150 | 131 |
| Tronoh | 978½* | — | — |
| Ulu Klang | — | — | — |

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

| | July | | August | |
|---|---|---|---|---|
| | Tin | Columbite | Tin | Columbite |
| Amalgamated Tin Mines | 461 | 69 | 440 | — |
| Anglo-Burma Tin* | 27 | — | — | — |
| Bangrin | 81 | — | 49 | — |
| Beralt | 4 | 175 | 5 | 184† |
| Bisichi | 60 | 60 | 47 | 43 |
| Ex-Lands Nigeria | 48 | — | 42 | — |
| Geevor | 55 | — | 38 | — |
| Gold and Base Metal | 70 | 9 | — | — |
| Jantar Nigeria | 21 | 22 | 16 | 20 |
| Jos Tin | 15½ | — | — | — |
| Kaduna Prospectors | 7½ | — | 8 | — |
| Kaduna Syndicate | 19 | — | 19 | — |
| Katu Tin | 37 | — | 45 | — |
| Keffi Tin | — | — | — | — |
| London Nigerian Mines | — | — | — | — |
| Mawchi Mines | — | — | — | — |
| Naraguta Extended | — | — | — | — |
| Naraguta Karama | 10 | — | — | — |
| Naraguta Tin | — | — | — | — |
| Renong Consolidated | — | — | — | — |
| Ribon Valley (Nigeria) | — | — | — | — |
| Siamese Tin Syndicate | 139 | — | 73 | — |
| South Bukeru | — | — | — | — |
| South Crofty | 65 | — | — | — |
| Tavoy Tin | — | — | — | — |
| Tin Fields of Nigeria | — | — | — | — |
| United Tin Areas of Nigeria | 20 | 3 | — | — |

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

*June, 1960.*

| | |
|---|---|
| Gold | 1,815,316 oz. |
| Silver | 183,243 oz. |
| Diamonds | 229,697 carats.* |
| Coal | 3,616,994 tons. |
| Copper | (*a*) — tons in matte and copper-gold concentrates. (*b*) 4,531 tons of 99·18%. |
| Tin | 228 tons concs. |
| Platinum (concentrates, etc.) | — |
| Platinum (crude) | — |
| Asbestos | 15,200 tons. |
| Chrome Ore | 80,047 tons. |
| Manganese Ore | 111,408 tons. |
| Lead Concs. | 28 tons. |

* *May, 1960.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

| | | June | July |
|---|---|---|---|
| Iron Ore | tons | 1,643,648 | 1,660,302 |
| Manganese Ore | ,, | 32,244 | 46,132 |
| Iron and Steel | ,, | 204,350 | 225,135 |
| Iron Pyrites | ,, | 9,910 | 44,127 |
| Copper Metal | ,, | 45,676 | 56,443 |
| Tin Ore | ,, | 6,622 | 4,925 |
| Tin Metal | ,, | 25 | 476 |
| Lead | ,, | 15,490 | 20,087 |
| Zinc Ore and Conc. | ,, | 30,004 | 27,348 |
| Zinc | ,, | 15,850 | 12,641 |
| Tungsten Ores | ,, | 598 | 668 |
| Chrome Ore | ,, | 27,084 | 34,489 |
| Bauxite | ,, | 21,221 | 32,283 |
| Antimony Ore and Concs. | ,, | 1,529 | — |
| Titanium Ore | ,, | 25,607 | 16,669 |
| Nickel Ore | ,, | — | — |
| Tantalite/Columbite | ,, | 21 | 47 |
| Sulphur | ,, | 32,539 | 50,320 |
| Barytes | ,, | 4,865 | 6,944 |
| Asbestos | ,, | 15,073 | 16,727 |
| Magnesite | ,, | 11,682 | 8,515 |
| Mica | ,, | 331 | 1,331 |
| Graphite | ,, | 942 | 770 |
| Mineral Phosphates | ,, | 93,486 | 125,506 |
| Molybdenum Ore | ,, | 750 | 664 |
| Nickel | cwt. | 43,205 | 46,822 |
| Aluminium | ,, | 610,354 | 347,977 |
| Mercury | lb. | 168,194 | 138,280 |
| Bismuth | ,, | 51,571 | 100,480 |
| Cadmium | ,, | 165,763 | 284,484 |
| Cobalt and Cobalt Alloys | ,, | 400,196 | 300,565 |
| Selenium | ,, | 33,393 | 23,751 |
| Petroleum Motor Spirit | 1,000 gals. | 62,209 | 53,622 |
| Crude | ,, | 1,055,150 | 904,959 |

## Prices of Chemicals

The figures given below represent the latest available.

| | | £ | s. | d. |
|---|---|---|---|---|
| Acetic Acid, Glacial | per ton | 106 | 0 | 0 |
| ,, ,, 80% Technical | ,, | 97 | 0 | 0 |
| Alum, Comml. | ,, | 25 | 0 | 0 |
| Aluminium Sulphate | ,, | 16 | 10 | 0 |
| Ammonia, Anhydrous | per lb. | | 2 | 0 |
| Ammonium Carbonate | per ton | 59 | 0 | 0 |
| ,, Chloride, 98% | ,, | 28 | 12 | 6 |
| ,, Phosphate (Mono- and Di-) | ,, | 102 | 0 | 0 |
| Antimony Sulphide, golden | per lb. | | 2 | 9 |
| Arsenic, White, 99/100% | per ton | 47 | 0 | 0 |
| Barium Carbonate 98–99% | ,, | 42 | 0 | 0 |
| ,, Chloride | ,, | 45 | 0 | 0 |
| Barytes (Bleached) | ,, | 20 | 0 | 0 |
| Benzene | per gal. | | 5 | 2 |
| Bleaching Powder, 35% Cl. | per ton | 30 | 7 | 6 |
| Borax | ,, | 46 | 0 | 0 |
| Boric Acid, Comml. | ,, | 77 | 0 | 0 |
| Calcium Carbide | ,, | 40 | 17 | 9 |
| ,, Chloride, solid, 70/75% | ,, | 13 | 5 | 0 |
| Carbolig Acid, crystals | per lb. | | 1 | 6 |
| Carbon Bisulphide | per ton | 62 | 10 | 0 |
| Chromic Acid (ton lots) | per lb. | | 2 | 2¾ |
| Citric Acid | per cwt. | 9 | 15 | 0 |
| Copper Sulphate | per ton | 85 | 0 | 0 |
| Creosote Oil (f.o.r. in Bulk) | per gal. | | 1 | 2 |
| Cresylic Acid, refined | ,, | | 7 | 0 |
| Hydrochloric Acid 28° Tw. | per carboy | | 11 | 6 |
| Hydrofluoric Acid, 59/60% | per lb. | | 1 | 1 |
| Iron Sulphate | per ton | 3 | 5 | 0 |
| Lead, Carbonate, white | ,, | 116 | 15 | 0 |
| ,, Nitrate | ,, | 110 | 0 | 0 |
| ,, Oxide, Litharge | ,, | 106 | 5 | 0 |
| ,, Red | ,, | 104 | 5 | 0 |
| Lime Acetate, brown | ,, | 40 | 0 | 0 |
| Lithopone | ,, | 57 | 10 | 0 |
| Magnesite, Calcined | ,, | 20 | 0 | 0 |
| ,, Raw | ,, | 13 | 0 | 0 |
| Magnesium Chloride, ex Wharf | ,, | 16 | 0 | 0 |
| ,, Sulphate, Comml. | ,, | 15 | 10 | 0 |
| Methylated Spirit, Industrial, 66 O.P. | per gal. | | 6 | 1 |
| Nickel Sulphate | per ton | 189 | 0 | 0 |
| Nitric Acid, 80° Tw. | ,, | 32 | 0 | 0 |
| Oxalic Acid | ,, | 132 | 0 | 0 |
| Phosphoric Acid (S.G. 1·750) | per lb. | | 1 | 4 |
| Potassium Bichromate | ,, | | 1 | 2¼ |
| ,, Bromide | ,, | 11 | 2 | 6 |
| ,, Carbonate (hydrated) | per ton | 74 | 10 | 0 |
| ,, Chloride | ,, | 21 | 0 | 0 |
| ,, Iodide | per kilo | | 15 | 3 |
| ,, Amyl Xanthate | ,, | Nominal | | |
| ,, Hydrate (Caustic) flake | per ton | 92 | 0 | 0 |
| ,, Nitrate | per cwt. | 4 | 1 | 0 |
| ,, Permanganate | per ton | 198 | 0 | 0 |
| ,, Sulphate, 50% | ,, | 20 | 13 | 0 |
| Sal-Ammoniac | ,, | 70 | 0 | 0 |
| Sodium Acetate | ,, | 63 | 0 | 0 |
| ,, Arsenate, 58–60% | ,, | Nominal | | |
| ,, Bicarbonate | ,, | 18 | 10 | 0 |
| ,, Bichromate | per lb. | | 1 | 0 |
| ,, Carbonate (Soda Ash) 58% | ,, | 16 | 0 | 0 |
| ,, Chlorate | ,, | 77 | 0 | 0 |
| ,, Cyanide | per cwt. | 6 | 18 | 10 |
| ,, Hydrate, 76/77%, solid | per ton | 33 | 0 | 0 |
| ,, Hyposulphite, Comml. | ,, | 35 | 0 | 0 |
| ,, Nitrate, Comml. | ,, | 29 | 0 | 0 |
| ,, Phosphate (Dibasic) | ,, | 40 | 10 | 0 |
| ,, Prussiate | per lb. | | 1 | 0½ |
| ,, Silicate | per ton | 11 | 10 | 0 |
| ,, Sulphate (Glauber's Salt) | ,, | 9 | 15 | 0 |
| ,, ,, (Salt-Cake) | ,, | 10 | 0 | 0 |
| ,, Sulphide, flakes, 60/62% | ,, | 38 | 12 | 6 |
| ,, Sulphite, Comml. | ,, | 27 | 15 | 0 |
| Sulphur, American, Rock (Truckload) | ,, | 13 | 0 | 0 |
| ,, Ground, Crude | ,, | 17 | 10 | 0 |
| Sulphuric Acid, 168° Tw. | ,, | 12 | 0 | 0 |
| ,, ,, free from Arsenic, 140° Tw. | ,, | 8 | 10 | 0 |
| Superphosphate of Lime, 18% $P_2O_5$ | ,, | 14 | 18 | 6 |
| Tin Oxide | ,, | Nominal | | |
| Titanium Oxide, Rutile | ,, | 172 | 0 | 0 |
| ,, White, 25% | ,, | 85 | 0 | 0 |
| Zinc Chloride | ,, | 95 | 0 | 0 |
| ,, Dust, 95/97% (4-ton lots) | ,, | 136 | 0 | 0 |
| ,, Oxide | ,, | 105 | 0 | 0 |
| ,, Sulphate | ,, | 32 | 0 | 0 |

# Share Quotations

Shares of £1 par value except where otherwise stated.

| GOLD AND SILVER: | Aug 9, 1960 £ s. d. | Sept. 8, 1960 £ s. d. |
|---|---|---|
| SOUTH AFRICA: | | |
| Blinkpoort (5s.) | 2 17 6 | 3 6 3 |
| Blyvooruitzicht (2s. 6d.) | 1 5 3 | 1 6 6 |
| Bracken (10s.) | 1 5 6 | 1 6 0 |
| Brakpan (3d.) | 3 9 | 3 9 |
| Buffelsfontein (10s.) | 2 0 6 | 2 2 6 |
| City Deep | 13 6 | 13 9 |
| Consolidated Main Reef | 13 0 | 13 0 |
| Crown Mines (10s.) | 1 1 0 | 1 1 3 |
| Daggafontein (5s.) | 17 3 | 18 0 |
| Dominion Reefs (5s.) | 10 6 | 10 3 |
| Doornfontein (10s.) | 1 8 9 | 1 8 6 |
| Durban Roodepoort Deep (10s.) | 1 4 0 | 1 5 0 |
| East Champ d'Or (2s. 6d.) | 1 6 | 1 9 |
| East Daggafontein (10s.) | 7 9 | 7 9 |
| East Geduld (4s.) | 14 9 | 16 6 |
| East Rand Ext. (5s.) | 18 0 | 19 0 |
| East Rand Proprietary (10s.) | 1 5 3 | 1 7 6 |
| Freddies Consol. | 1 9 | 2 3 |
| Free State Dev. (5s.) | 4 0 | 4 3 |
| Free State Geduld (5s.) | 5 18 3 | 6 10 0 |
| Free State Saaiplaas (10s.) | 9 9 | 10 0 |
| Geduld | 2 5 0 | 2 6 3 |
| Government Gold Mining Areas (3d.) | 2 9 | 3 0 |
| Grootvlei (5s.) | 16 9 | 18 3 |
| Harmony (5s.) | 1 9 3 | 1 12 3 |
| Hartebeestfontein (10s.) | 2 3 0 | 2 6 6 |
| Libanon (10s.) | 11 9 | 12 3 |
| Loraine (10s.) | 1 4 3 | 1 4 6 |
| Luipaards Vlei (2s.) | 6 6 | 6 9 |
| Marievale (10s.) | 1 4 0 | 1 5 0 |
| Modderfontein B (3d.) | 1 9 | 1 6 |
| Modderfontein East | 12 0 | 12 0 |
| New Kleinfontein | 3 0 | 3 6 |
| New Pioneer (5s.) | 1 9 0 | 1 11 6 |
| New State Areas (15s. 6d.) | 9 | 9 |
| President Brand (5s.) | 2 18 3 | 3 4 3 |
| President Steyn (5s.) | 1 1 6 | 1 2 3 |
| Rand Leases (9s. 3d.) | 6 0 | 6 0 |
| Randfontein | 14 6 | 14 3 |
| Rietfontein (3d.) | 3 0 | 3 0 |
| Robinson Deep (5s. 6d.) | 4 0 | 4 0 |
| Rose Deep (3d.) | 6 9 | 6 9 |
| St. Helena (10s.) | 3 4 6 | 3 14 6 |
| Simmer and Jack (1s. 6d.) | 9 | 1 0 |
| South African Land (3s. 6d.) | 11 9 | 12 9 |
| Springs (3d.) | 1 3 | 1 3 |
| Stilfontein (5s.) | 1 10 6 | 1 12 3 |
| Sub Nigel (3d.) | 8 0 | 8 0 |
| Vaal Reefs (5s.) | 2 0 0 | 2 2 9 |
| Van Dyk (3d.) | 2 6 | 2 6 |
| Venterspost (10s.) | 19 0 | 1 1 3 |
| Virginia (5s.) | 3 0 | 3 0 |
| Vlakfontein (10s.) | 15 0 | 15 0 |
| Vogelstruisbult (3d.) | 4 6 | 4 6 |
| Welkom (5s.) | 13 9 | 14 3 |
| West Driefontein (10s.) | 4 1 0 | 4 6 3 |
| West Rand Consolidated (10s.) | 16 0 | 16 9 |
| West Witwatersrand Areas (2s. 6d.) | 2 13 9 | 3 1 3 |
| Western Holdings (5s.) | 5 18 9 | 6 15 0 |
| Western Reefs (5s.) | 1 4 3 | 1 6 3 |
| Winkelhaak (10s.) | 1 3 9 | 1 4 0 |
| Witwatersrand Nigel (2s. 6d.) | 1 0 | 1 0 |
| Zandpan (10s.) | 13 0 | 13 3 |
| RHODESIA: | | |
| Cam and Motor (2s. 6d.) | — | — |
| Chicago-Gaika (10s.) | 15 0 | 15 0 |
| Coronation (2s. 6d.) | 5 0 | 5 0 |
| Falcon (5s.) | 10 6 | 10 6 |
| Globe and Phœnix (5s.) | 1 10 0 | 1 11 3 |
| Motapa (5s.) | — | — |
| GOLD COAST: | | |
| Amalgamated Banket (3s.) | 9 | 9 |
| Ariston Gold (3s. 6d.) | 3 9 | 3 6 |
| Ashanti Goldfields (4s.) | 17 6 | 17 9 |
| Bibiani (4s.) | 2 6 | 2 3 |
| Bremang Gold Dredging (5s.) | 3 0 | 2 9 |
| Ghana Main Reef (5s.) | 2 3 | 2 0 |
| Konongo (2s.) | 1 6 | 1 3 |
| Kwahu (2s.) | 5 6 | 5 3 |
| Offin River (2s. 6d.) | 3 9 | 3 3 |
| Western Selection (5s.) | 4 6 | 4 3 |
| AUSTRALASIA: | | |
| Gold Fields Aust. Dev. (3s.), W.A. | 1 3 | 1 6 |
| Gold Mines of Kalgoorlie (10s.) | 7 3 | 8 3 |
| Great Boulder Propriet'y (2s.), W.A. | 11 0 | 11 3 |
| Lake View and Star (4s.), W.A. | 1 6 0 | 1 6 6 |
| Mount Morgan (10s.), Q. | 15 9 | 15 3 |
| New Guinea Gold (4s. 3d.) | 1 9 | 1 9 |
| North Kalgurli (1912) (2s.), W.A. | 9 9 | 9 6 |
| Sons of Gwalia (10s.), W.A. | 2 3 | 2 3 |
| Western Mining (5s.), W.A. | 10 9 | 9 9 |

| | Aug 9, 1960 £ s. d. | Sept. 8, 1960 £ s. d. |
|---|---|---|
| MISCELLANEOUS: | | |
| Fresnillo ($1·00) | 1 5 0 | 1 6 3 |
| Kentan Gold Areas | 1 4 3 | 1 2 3 |
| St. John d'el Rey, Brazil | 3 16 3 | 4 2 6 |
| Yukon Consolidated ($1) | 4 3 | 4 3 |
| COPPER: | | |
| Bancroft Mines (5s.), N. Rhodesia | 18 6 | 19 6 |
| Esperanza (2s. 6d.), Cyprus | 1 9 | 1 9 |
| Indian (2s.) | 5 0 | 5 0 |
| MTD (Mangula) (5s.) | 8 0 | 8 0 |
| Messina (5s.), Transvaal | 19 3 | 19 3 |
| Mount Lyell (5s.), Tasmania | 5 3 | 6 0 |
| Nchanga Consolidated, N. Rhodesia | 2 15 0 | 2 15 0 |
| Rhokana Corporation, N. Rhodesia | 2 6 9 | 2 11 0 |
| Roan Antelope (5s.), N. Rhodesia | 5 6 | 6 3 |
| Tanganyika Concessions (10s.) | 1 9 6 | 1 11 0 |
| LEAD-ZINC: | | |
| Broken Hill South (1s.), N.S.W. | 11 6 | 11 3 |
| Burma Mines (3s. 6d.) | 1 6 | 1 6 |
| Consol. Zinc Corp. Ord. | 3 15 6 | 3 17 3 |
| Lake George (5s.), N.S.W. | 4 3 | 4 0 |
| Mount Isa, Queensland (5s. Aust.) | 2 12 0 | 2 15 0 |
| New Broken Hill (5s.), N.S.W. | 2 12 6 | 2 11 3 |
| North Broken Hill (10s.), N.S.W. | 19 9 | 19 6 |
| Rhodesia Broken Hill (5s.) | 7 9 | 7 9 |
| San Francisco (10s.), Mexico | 1 0 3 | 19 3 |
| TIN: | | |
| Amalgamated Tin (5s.), Nigeria | 10 3 | 10 0 |
| Ampat (4s.), Malaya | 11 9 | 12 6 |
| Ayer Hitam (5s.), Malaya | 1 2 0 | 1 5 3 |
| Beralt (5s.), Portugal | 1 12 3 | 1 13 3 |
| Bisichi (2s. 6d.), Nigeria | 5 9 | 5 6 |
| Ex-Lands (2s.), Nigeria | 3 0 | 3 0 |
| Geevor (5s.), Cornwall | 1 2 9 | 18 3 |
| Gold Base Metals (2s. 6d.), Nigeria | 2 0 | 2 0 |
| Hongkong (5s.), Malaya | 10 6 | 10 3 |
| Jantar Nigeria (3s.) | 6 3 | 6 0 |
| Kaduna Syndicate (2s.), Nigeria | 3 0 | 2 9 |
| Kamunting (5s.), Malaya | 15 3 | 17 6 |
| Malayan Tin Dredging (5s.) | 1 3 6 | 1 7 0 |
| Mawchi Mines (4s.), Burma | 1 0 | 1 0 |
| Naraguta Karama (5s.), Nigeria | 1 7½ | 1 6 |
| Pahang (5s.), Malaya | 10 9 | 12 0 |
| Siamese Synd. (5s.) | 12 9 | 13 9 |
| South Crofty (5s.), Cornwall | 4 6 | 4 3 |
| Southern Kinta (5s.), Malaya | 1 4 9 | 1 5 3 |
| Southern Malayan (5s.) | 17 6 | 1 2 3 |
| Southern Tronoh (5s.), Malaya | 1 1 6 | 1 2 6 |
| Sungei Besi (4s.), Malaya | 1 7 0 | 1 8 6 |
| Sungei Kinta, Malaya | 15 0 | 15 0 |
| Tekka (12s. 6d.), Malaya | 9 6 | 9 9 |
| Tronoh (5s.), Malaya | 1 17 0 | 1 19 6 |
| United Tin Areas (2s. 6d.), Nigeria | 2 4½ | 2 3 |
| DIAMONDS: | | |
| Anglo American Investment | 11 10 0 | 11 15 0 |
| Consol African Selection Trust (5s.) | 1 2 0 | 1 3 3 |
| Consolidated of S.W.A. Pref. (10s.) | 10 6 | 10 6 |
| De Beers Deferred (5s.) | 7 0 3 | 7 7 6 |
| FINANCE, Etc. | | |
| African & European (10s.) | 3 2 6 | 3 2 6 |
| Anglo American Corporation (10s.) | 7 6 0 | 7 16 3 |
| Anglo Transvaal 'A' (5s.) | 1 17 6 | 1 17 6 |
| British South Africa (15s.) | 3 15 9 | 3 14 6 |
| British Tin Investment (10s.) | 1 10 0 | 1 10 6 |
| Broken Hill Proprietary | 3 12 6 | 3 13 0 |
| Camp Bird (10s.) | 7 9 | 10 3 |
| Central Mining | 3 10 3 | 3 15 0 |
| Central Provinces Manganese (10s.) | 1 6 9 | 1 7 9 |
| Consolidated Gold Fields | 2 18 3 | 3 7 6 |
| Consolidated Mines Selection (10s.) | 1 9 6 | 1 11 0 |
| Corner House | 14 9 | 14 6 |
| East Rand Consolidated (5s.) | 2 6 | 2 0 |
| Free State Development (5s.) | 4 0 | 4 3 |
| General Exploration O.F.S. (2s. 6d.) | 3 9 | 4 0 |
| General Mining and Finance | 4 7 6 | 5 1 3 |
| Hendersons (4s.) | 9 0 | 8 9 |
| Johannesburg Consolidated | 2 8 9 | 2 11 6 |
| London & Rhod. M. & L. (5s.) | 5 0 | 5 3 |
| London Tin Corporation (4s.) | 12 0 | 12 6 |
| Lydenburg Est. (5s.) | 13 3 | 13 3 |
| Marsman Investments (10s.) | 1 10½ | 2 9 |
| National Mining | 2 0 | 2 6 |
| Rand Mines (5s.) | 3 11 6 | 3 16 3 |
| Rand Selection (5s.) | 2 2 3 | 2 6 6 |
| Rhodesian Anglo American (10s.) | 2 19 3 | 3 1 9 |
| Rhodesian Corporation (5s.) | 2 6 | 2 6 |
| Rhodesian Selection Trust (5s.) | 9 6 | 10 6 |
| Rio Tinto (10s.) | 1 10 0 | 1 13 0 |
| Selection Trust (10s.) | 4 6 6 | 4 9 3 |
| South West Africa Co. (3s. 4d.) | 13 9 | 13 9 |
| Union Corporation (2s. 6d.) | 2 10 3 | 2 15 6 |
| Vereeniging | 4 17 6 | 4 19 6 |
| West Rand Inv. Trust (10s.) | 2 4 0 | 2 10 0 |

# THE MINING DIGEST

## A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

*In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.*

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## A Chibougamau Mill

The issue of the *Precambrian* for July contains a comprehensive account of operations at Opemiska Copper Mines (Quebec), Ltd., "Copper Pioneer of the Chibougamau," prepared by R. Guimond with the help of the mine staff. Work on this property in north central Quebec, where in 1936 exploration had indicated a reserve of 283,000 tons of ore averaging 7·4% copper with 0·13 oz. in gold per ton, was suspended in 1937 and remained dormant until 1951. New drilling starting there resulted in the discovery of the No. 3 vein which brought the indicated reserves to 1,000,000 tons. Although it was not realized at the time the No. 3 ore zone is the most important ore structure found in the history of the property and which, to-day, contains over 80% of the present ore reserves. The operation started on a modest scale of 400 tons of ore per day at the end of 1953. With the availability of Hydro-Quebec power in the summer of 1955 production was increased to 800 tons per day by enlarging the mill capacity. All ore hoisting and underground servicing until November of 1959 was done through the original shaft, Springer No. 1. Since that time Springer No. 2, which was part of the recent development programme, has now become the main ore-hoisting shaft. Prior to the sinking of the Springer No. 2 the Perry shaft had been sunk, near the centre of the property, to a depth of 2,000 ft. for the purpose of developing the Perry zone and general exploration to the east and at depth.

The ore-bodies are mainly of the vein type, although disseminated mineralization of a replacement type extends in to the walls of some parts of most veins. The main veins occur near the nose of a folded gabbro sill. The axis of this fold strikes roughly east–west and plunges eastward at about 50°. Rhyolite lies immediately below the west end and the north limb of the gabbro sill. Inside the trough formed by the eastward-plunging fold and immediately above the gabbro are bands of altered pyroxenite. Mineralization following east–west fractures forms the main ore-bodies. These occur in the Springer mine and are approximately parallel. They comprise the present ore reserves.

In the mine three conventional stoping methods are employed. Shrinkage stoping, the original method, has continued to be used in the narrow to medium-width veins varying from 4 ft. to 20 ft. wide. Stoping lengths are influenced by ore grade and may vary from 50 ft. to 600 ft. When the inclination of the footwall is less than 45° a few shrinkage stopes have been modified to a panel type stope where the 30-ft. length panel is mined open, or shrunk, emptied, and backfilled, before proceeding to the next panel. In all shrinks hydraulic washing is used to facilitate pulling and cleaning the completed stope. Rock bolts are used exclusively for wall support unless the stope is 5 ft. or narrower in width. Then cut-and-fill stoping in the 10 ft. to 30 ft. width veins provides 35% of the ore hoisted.

A 36 in. by 48 in. Birdsboro-Buchanan jaw-crusher located underground produces *minus* 5-in. product for the surface crushing plant. Coarse-ore storage on surface is a 500-ton round steel bin with bottom feeding by means of a 36 in. by 72 in. Syntron vibrating grizzly feeder. Primary crusher oversize from the feeder is reduced to *minus* 1 in. with the secondary 5½-ft. Symons cone-crusher. Grizzly undersize and standard crusher products are then screened on two 5 ft. by 12 ft. double-deck Dillon vibrating screens, where limiting size is $\frac{5}{16}$ in. by 3 in. The *plus* product is retained in closed circuit with the tertiary 5½-ft. Symons short-head crusher for reduction to all *minus* $\frac{5}{16}$ in. Conveying system is Stephens-Adamson and carrier belts are all 30 in. wide. A 30-in. Dings self-cleaning magnet located at the head of the conveyor feeding the standard cone-crusher protects equipment from tramp steel. Rated plant capacity is 250 t.p.h. and crushing is accomplished on two shifts, six days a week.

Fine-ore storage for grinding consists of one 4,000-ton catenary and two 500-ton wood stave bins. Collecting conveyors supply feeder belts at 2,000 t.p.d. to one 8 ft. by 72 in. Hardinge conical ball-mill in closed circuit with a 6 ft. by 14 ft. counter-current classifier and two Hardinge tricone ball-mills closed with 8 ft. by 32 ft. Dorr HX classifiers. Overflow is controlled at 8·0% on 65 mesh. Grinding media is 2½ in. to 3 in. and mill liners used are of Ni-Hard.

Denver super-conditioners, one 6 ft. by 6 ft. and two 6 ft. by 8 ft., receive classifier overflow with total retention time of 7 min.; then overflow is pumped to a 3-way Denver distributor feeding parallel banks of 17 No. 24 Denver rougher flotation cells, with the last six on each bank used as scavengers and having a retention time of 18 min. Rougher concentrates are collected, cleaned, and recleaned in nine No. 24 Denver cells. Combined cleaner tails and scavenger concentrates make up the feed to regrinding, consisting of two 10-in. Krebs cyclones in closed circuit with a 8 ft. by 72 in. Hardinge conical ball-mill, charged with 1¼-in. Ni-Hard balls; cyclone overflow after classification is returned to rougher feed at *minus* 200 mesh.

Final concentrates are collected from the first 2–3 rougher and the recleaner cells, then pumped to

two 8-in. cyclones where 50% of the solids are removed directly to three 6-ft. (2–4 disc and 1–2 disc) Denver filters. Cyclone overflow is thickened in two 30 ft. by 12 ft. Dorr thickeners and is then pumped to the filters. In addition overflow water and filtrate are settled in a spare duplicate thickener where removal of slime fraction is completed before water is recirculated to the grinding circuit steady-head tank.

Lime is fed to the primary ball-mills by a Denver dry reagent feeder, to maintain a pH of 10·0 to 10·4 in the rougher flotation circuit, and to the thickeners to maintain pH 11·0 for settling; total consumption is 0·65 lb./ton. Clarkson and Denver wet disc feeders add reagent 208 and T.E.B. frother to grinding while Z-6 and T.E.B. are staged to flotation; consumption is 0·07 lb./t. R-208, 0·07 lb./t. T.E.B. and 0·01 lb./t. Z-6. Sodium sulphite at 0·15 lb./t. is fed to the cleaner circuit for pyrite depression and up-grading of rougher concentrates.

The backfill sand plant located in the mill recovers 50% of the sands in tailings after two-stage classification with 2–20 in. Krebs cyclones. Percolation rate is 5 in. to 7 in./hour from the second-stage cyclone. Storage is held in 2 175-ton wood-stave tanks, then when called for to a 3-in. D.D. hole located under the tanks. Tailings slimes are carried by 10-in. wood-stave pipe to a disposal basin located 1,500 ft. from the mill.

Concentrates at 230 t.p.d. to 240 t.p.d. and 9·0% to 9·5% moisture, grading 25·0% copper, 0·250 oz. per ton Au, and 3·0 oz. Ag, are conveyed over a Merrick weightometer, weighed, and loaded into open rail cars for shipment to Noranda Smelter. All pumping of mill pulps is handled by C.A.-C. SRL and SRL-C pumps. Denver automatic wet samplers cut main 24-hour mill samples for assay. Laboratory and sample rooms are equipped to handle bench flotation tests as well as operating control assays.

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# A Gas Occurrence at Mount Isa

In the *Queensland Government Mining Journal* for March 20 T. J. Brady describes an occurrence of "Hydrocyanic Acid Gas in Underground Workings at Mount Isa." He says that during the afternoon shift of Friday, August 7, 1959, two miners were overcome by gas while replacing ladders in K73 Fill Pass rise above 4 level. A serious accident was averted by the quick-thinking of one of the men who, after falling a distance of nearly 20 ft. down the rise immediately turned on an air hose and climbed to his mate who had collapsed across the ladders. This man recovered almost immediately after inhaling the fresh air. The shift boss arrived at the rise very shortly after the incident and both men were taken to the surface and sent to hospital for observation. Apart from minor lacerations neither man suffered any after-effects.

Work in the rise was stopped until an inspection was carried out by the ventilation engineer and the level foreman at 9 a.m. on the following morning. No sign of gas was detected. However, a compressed-air hose had been blowing in the rise since the accident and it was decided to make another inspection on Monday morning after the rise had been left without ventilation for 48 hours. The second inspection was carried out at 2 p.m. on Monday. Tests were taken with an M.S.A. carbon monoxide detector and a flame safety lamp at regular intervals up the rise. All tests were negative. However, at approximately 35 ft. above the level the ventilation engineer noticed a sweetish smell and suddenly felt very dizzy. While climbing down he found his limbs were "rubbery" and hard to control, but upon reaching fresh air at the bottom of the rise recovery was almost immediate. As a result of this inspection it was concluded that: (1) A highly toxic gas was present in the rise: (2) the gas had no pronounced odour—the sweetish smell could have been due to stale air: (3) the gas was lighter than air, and (4) the gas was not carbon monoxide. On checking through the properties of gases lighter than air it was noted that hydrocyanic acid gas (HCN) has properties which agreed with the above conclusions, which of course are far from diagnostic.

Since K73 pilot hole was drilled on the edge of a tailings dam known to contain some cyanide it was decided to test the rise atmosphere for HCN. In order to collect a sample of the rise atmosphere for chemical analysis the underground fire officer and the ventilation engineer climbed to the top of the rise using oxygen breathing apparatus. Tests taken with the carbon monoxide detector at regular intervals were all negative and observations of the flame in a safety lamp indicated that there was no oxygen deficiency and that the atmosphere was neither inflammable nor explosive. Plastic tubing of approximately $\frac{3}{16}$-in. diameter was tied in position at the top stage about 10 ft. below the back of the rise, the other end of the tube being run into a bottle of caustic soda solution on 4 level as the cyanide radical is soluble in caustic soda. Air from the top of the rise was drawn through the solution by means of a water aspirator for approximately 45 min.

Preliminary tests carried out by the senior chemist gave some evidence of the presence of cyanide and it was decided to collect a second sample over a longer period. Laboratory tests of this sample which had been collected over 15½ hr. gave definite confirmation of the presence of cyanide.

Several samples were taken in an attempt to gauge the concentration of cyanide, but the results were much lower (a maximum of 10 parts per million) than was anticipated from the results of the qualitative tests and the symptons of the affected personnel. The latter would indicate a concentration of the order of 150 parts per million.

Instructions were issued by the mine superintendant requiring the rise to be adequately ventilated by both a compressed-air line and a vent line from fans situated in an intake airway. Work then recommenced in the rise and no further trouble has been experienced.

Hydrocyanic acid may be generated by the action of dilute sulphuric acid on potassium or sodium cyanide.

$$KCN + H_2SO_4 = KHSO_4 + HCN$$

It is a colourless liquid with a peculiar sickly

smell and may have a faint odour of bitter almonds. Its boiling point is 78 deg. F. and it is slightly lighter than air, having a gas density of 13·5. The poison acts on the central nervous system and can enter the body by skin absorption as well as by inhalation. "Hydrocyanic' acid is highly poisonous, being remarkable not so much for the quantity needed to cause death as for the violence and rapidity with which it acts. Death occurs commonly within two minutes and if the victim survives for half an hour he will almost certainly recover "(Sherwood Taylor "Inorganic and Theoretical Chemistry" 8th Ed. p. 432).

The following scale of toxicity is given in the catalogue of industrial safety appliances issued by the Mine Safety Appliance Company—

| | *p.p.m.* |
|---|---|
| Odour detectable at approximately . . | 1 |
| Slight symptons of headache, nausea, or drowsiness after several hours . . | 18–36 |
| Tolerated for half to one hour without immediate or later effects . . . | 45–54 |
| Fatal after half to one hour or dangerous to life . . . . . | 110–135 |
| Fatal after 30 minutes . . . . . | 135 |
| Fatal after 10 minutes . . . . . | 181 |
| Immediately fatal . . . . . | 270 |

*Origin of the Gas*

K73 Fill Pass is to be a vertical connexion between 4 level and the surface, the collar being on the western edge of No. 2 Tailings dam. At the time of the accident the back of the rise was 74 ft. above 4 level and approximately 12 ft. below the bottom of the churn-drill hole, which was drilled as a pilot hole for the rise. Geologically the fill pass is in the foot-wall of No. 7 ore-body (lead). The proposed fill pass is situated in a zone of heavy shearing and fracturing. It is reasonably certain that the country is permeable as the drill hole is dry throughout its entire length.

Although cyanide is used as a reagent in the flotation process at Mount Isa and is certainly present in the tailings, no records are available from which some idea of the concentration of cyanide could be obtained. The dams were completed about 1946 and contain approximately 4,900,000 cu. yd. of tailings, so that assuming the tailings water, which has not evaporated, has percolated to the low-lying sections of the original surface, a fairly high concentration of cyanide could be expected at the lower levels of the dam.

An inferred transverse fault shown in geological cross-section would provide an entry for this cyanide-bearing water to the shear zone. In percolating downwards the water would come in contact with the sheared pyritic shale and/or the lead ore intersection which would provide a source of sulphuric acid leading to the reaction :—

$$Ca(CN)_2 + H_2SO_4 = CaSO_4 + 2HCN$$

The production of $CaSO_4$ (gypsum) by mine water is a common occurrence and stalactites and stalagmites of gypsum can be seen in many parts of the workings. A vugh would provide an ideal surface for the precipitation of gypsum enabling a gaseous mixture of water vapour and hydrocyanic acid gas to form within the vugh. In sheared and fractured country such as this it is quite possible that many such pockets of gas have formed and are interconnected by fissures, one of which intersects the back of the rise. In support of this hypothesis the strongest concentration of gas occurs about mid-afternoon. This corresponds with the lowest barometric pressure of the day. It would appear therefore that the country between the surface and 4 level is so fractured that air or gases entrained therein are at atmospheric pressure and thus expand or contract with fluctuations in atmospheric pressure.

Although it would seem that as hydrocyanic acid gas is lighter than air it should slowly work its way to the surface and escape to atmosphere, it seems reasonable to suppose that the tailings dam acts as in impermeable barrier thus containing the gas within the shear zone.

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# Ammonium Nitrate as Explosive

In the *Mining and Chemical Engineering Review* of Melbourne for June 15 there is an article by R. F. Bennett entitled "Ammonium Nitrate as an Explosive" from which the following notes have been abstracted. The author says that although ammonium nitrate has been used to an increasing extent in commercial explosives since World War I it was not until Akremite (ammonium nitrate and carbon black) was introduced in 1954 by Lee and Akre of Maumee Collieries, North America, that the "onsite" manufacture of low-cost blasting agents using fertiliser-grade (prilled) ammonium nitrate as the main ingredient became possible.

Ammonium nitrate may be manufactured by several methods which produce different physical characteristics although chemically they are identical. In each process the first stage is the concentration of a solution by removal of water. This may be done by :—

(1) Vacuum evaporation at high temperature, as in the prilling process, and spraying the concentrate into a shot tower to form round pellets which solidify while falling countercurrent to a blast of air.

(2) In the Stengel process by cooling the hot concentrated solution on a water-cooled Sandvik belt after which the resultant cake is ground and screened to the desired particle size.

(3) By open pan evaporation at atmospheric pressure, as in the graining process where the hot solution is allowed to cool at a controlled rate in graining kettles to form the desired size.

Ammonium nitrate produces a larger gas volume upon detonation than any other explosive material commonly used. In its pure state it is difficult to detonate and to handle as it sets on storage. As a rule it is coated with a small percentage of kieselguhr to prevent setting during storage and as such it may be transported as a non-explosive.

Ammonium nitrate may be sensitized by various fuels; in fact the Swedish scientists Ohlsson and Norrbin patented explosive mixtures of ammonium nitrate with charcoal, sawdust, napthalene, wood pulp, and nitrobenzene as early as 1867. These patents were later acquired by Alfred Nobel.

The DuPont Co. in 1932 introduced " Nitramon ", which is a fuel-sensitized ammonium nitrate packed in cans of various diameters and which requires a special high-explosive primer to initiate it.

Lee and Akre in 1954 patented " Akremite ", which consists of a mixture of fertiliser-grade ammonium nitrate and carbon black contained in expansible plastic cylinders. The DuPont Co. obtained world rights for " Akremite ", but explosives users soon realized that there was no advantage in using the polyethylene containers in dry holes and they were not entirely satisfactory in wet holes.

As the pertinent feature of the patent was the expansible plastic bag it soon became the practice to mix the ingredients down the hole. For " on site " mixing solid fuels have been largely replaced by a light oil for reasons of economy, convenience, and availability.

Although the mixture of ammonium nitrate and a sensitizing material is regarded as an explosive under the various Explosives Acts in North America, they come under the classification of nitro-carbonitrates for transport by rail and road and qualify for a freight rate much lower than explosives. This permits the United States explosives manufacturers to put a cheap factory-mixed blasting agent on the market and in many instances operators prefer the ready-mixed product to the " on site " manufacture for reasons of economy and efficiency

The large open-pits in Arizona operated by the Phelps Dodge Corporation use the Apache Powder Co. blasting agent " Carbamite ", which is a grained ammonium nitrate sensitized with oil and other carbonaceous materials. This blasting agent is transported by rail from the factory direct to the mines, packed in paper or burlap bags ready to drop down the holes.

To obtain a good oxygen-balanced mixture 6% by weight of oil is added, although slight variations are not critical. Six pints of dieselene to 100 lb. of " Nitrex " is recommended for premixed charges.

The ultimate in simplicity in mixing is to pour the two ingredients down the hole simultaneously in the correct proportions or to pour the oil into the bag and allow it to thoroughly coat the ammonium nitrate before tipping down the hole. Some kind of premixing by mechanical means is desirable. For small quantities the plastic-lined 2 or 3 cu. ft. hand-operated concrete mixer is ideal, but for large quantities self-contained mobile powder blowing units which automatically mix the ingredients as they are blown into the loading hose are in use. The mixer design should avoid possibilities of frictional heating, compaction, and confinement. Open mixers which can be cleaned readily are preferred to enclosed designs. Surfaces in contact with ammonium nitrate may be coated with an epoxy resin or fibreglass to prevent corrosion.

High-explosive primers or their equivalent are required to initiate A.N./fuel mixtures. The size and type of primer is influenced largely by the diameter of the hole, the degree of confinement, and general blasting conditions. Providing the primer charges are in sufficient quantity and properly distributed the greater the resistance offered by the rock the nearer will the velocity of detonation approach that of the priming explosive ; at the same time it will not exceed it.

It is an established fact that each explosive or explosive mixture has a characteristic maximum rate of detonation for a given density and diameter and, at the same time, if an explosive is improperly initiated or has been desensitized a detonation wave can progress through the explosive at a rate much less than its maximum rate. This is true of ammonium nitrate because of its insensitive properties and relatively low heat of explosion. The calculated velocity for a 9 in. diameter hole charged with 94/6 A.N./oil mixture is 3,100±300 m.p.s., and for a 3½ in. hole 2,400 m.p.s. Bore-hole tests with a 94/6 " Nitrex "/oil charge in 3½ in. hole in basalt recorded a velocity of 3,500 m.p.s.

In general the percentage of primer and the distance between primers in the A.N./oil column is controlled by the bore-hole diameter. For holes 2 in. to 4 in. diameter the primer percentage of standard high explosive " Quarigel " (or A.N. Gelignite " 60 ") should be 20% to 25% and the spacing of the primers 10 ft. apart. Holes 4 in. to 7 in. diameter require 10% and 20 ft. spacing. From 7 in. upwards 5% priming in a single primer should be sufficient.

Large-diameter detonating fuse (400 grain/ft.), Pentolite boosters, and plastic bags containing 98/2 uncoated A.N./oil cap sensitive mixtures are being used to some extent as primers in America, but it is common practice to prime large-diameter holes in more than one place with the standard high-strength dynamites attached to one or two lengths of 50-grain detonating fuse. It is claimed that maximum detonation pressure is obtained only after propagation of the detonation wave over a distance of 3 to 5 charge diameters even with an efficient primer.

Although uncoated ammonium nitrate is more sensitive to detonation than kieselguhr-coated A.N. it has been shown that the detonation velocity increases as much as 10% when 2% to 3% coating is added to A.N. prills. The coating apparently assists in the distribution of the oil and holds it in closer contact.

The velocity of detonation of A.N./fuel oil mixtures increases with loading density in a bore-hole. A.N. prills vary in density 0·68 to 0·86 gm./c.c. (" Nitrex " has a density of approximately 0·94 c.c./gm.) The density of loose poured prilled A.N./oil mixtures is about 0·75 and, when well tamped, over 0·9.

Dr. Melvin Cook in a paper to the American Mining Congress, October, 1959, states that the 94/6 A.N./fuel oil mixture, having a density of 0·8 gm./c.c., has a bore-hole pressure never exceeding 140 tons per sq. in. in comparison with 450 tons to 500 tons per sq. in. for the highest gelatine dynamites and A.N./T.N.T./water slurries used in open-pit mining to-day. Consequently a much larger bore-hole is required for a given charge with the A.N./fuel oil mixtures than when conventional explosives and slurries are used ; therefore the low cost of the former explosive is offset by higher drilling and shovel costs.

The North West Nitro-Chemical Co. of Canada is blending coarse and fine ammonium nitrate to increase the density of their product. By a substitution with 15% sodium nitrate and a slight increase in oil percentage higher density can be obtained, but still nothing in comparison with the 1·4 to 1·55 gm./c.c. obtained in conventional explosives and slurries. Cook and Farnam developed the A.N./T.N.T./water slurries now in use at the Iron Ore Company of Canada property at Knob Lake and other open-pit and quarrying operations in Canada. These slurries, for which Canadian Industries, Ltd., has world rights outside the U.S.A., have

no cost advantage over standard commercial explosives because they must be " factory " mixed and contain at least 25% T.N.T. which is costly. However, they may be used in holes containing water. They completely fill the bore-hole and lend themselves to bulk mixing, handling, and bulk loading methods. Naturally greater control and care in mixing and handling will be required than when using A.N./fuel oil mixtures and special priming is necessary.

Slurries can be formed with ammonium nitrate using non-explosive sensitizers such as molasses or sugar.

Ammonium nitrate has been used as the main constituent in conventional explosives for underground work for many years, but only in factory-mixed compositions based on nitroglycerine or T.N.T. Some mines in America have tried A.N./fuel blasting agents underground but no great interest has been shown for three reasons: (1) Low sensitivity; (2) lack of water resistance, and (3) low bulk strength.

Summing up the results of the tests, it would appear that the oxygen balance of the blasting agent is critical because any variation in the proportions of oil could mean a loss of power and the formation of nitrous oxides. Better results could possibly be obtained if a suitable combined mixing and loading device is designed. Fine A.N./oil is not free flowing and would be difficult to load by normal methods.

The U.S. Bureau of Mines has been carrying out an investigation of the toxic gases produced by A.N./diesel fuel compositions, dealing mainly with: (1) Variations in oxygen balance, (2) mode of initiation, (3) effect of water content, and (4) effect of inert coating. Conclusions were that the production of carbon monoxide for compositions of fuel content up to that of an oxygen-balanced mixture was much less than required by the American dynamite standard. On the other hand the production of oxides of nitrogen by A.N./D.F. mixtures is generally much greater than is expected from a dynamite and, furthermore, this excessive production of nitrous oxides is much worse when there is marginal initiation. The effect of water will further increase the production. The adequately initiated, nearly oxygen-balanced compositions show varying but generally high values for oxides of nitrogen ranging from 0·014 to 0·047 cu. ft. per pound in the absence of water, which is 20 times higher than the dynamite standard.

On the basis of these findings it is concluded that the current evidence is against the use of A.N./fuel compositions for underground blasting. Additional investigations are being made.

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# Tension Indicators on Roof Bolts

A note on the use of " Lock Washers as Tension Indicators " for roof bolts appears in the *South African Mining and Engineering Journal* for August 5. In the Union a device comprising a rubber pad bonded between two steel washers has been used widely as an indicator. As the tension of the bolt increased the rubber element expanded laterally and by measuring the circumference of the rubber with a calibrated gauge the bolt tension could be determined.

However, compression pads, it is stated, cannot be used with every roof bolt. These are scattered at intervals as is considered necessary by the particular mine management. In many cases, however, it is desirable that continuous information should be available as to whether the tension of all bolts is being maintained. Towards this a joint investigation is being carried out by a committee of the American Mining Congress, the U.S. Bureau of Mines, and six U.S. makers of helical springs into using lock washers which will measure tension directly. The washers are helical springs of one convolution, whose free height, internal diameter, and section are so designed that, under compression of the bolt head and roof plate, the washer will be compressed into a horizontal plane when the tension in the bolt reaches the designed load.

As far as design is concerned this can be determined mathematically and a formula arrived at for the production of a washer for almost any load and any diameter of bolt. In experimental work washers are being produced which will indicate loads within a tolerance of *plus* or *minus* 10%.

Test installations have been undertaken in various types of mines in the United States. It was found in some cases that washers did not close completely when a pre-set bolting machine cut off at what was thought to be the torque required to deliver the desired bolt tension. Investigations disclosed, however, that in the majority of cases the washers were not at fault, but that either the bolting machines were not properly adjusted or that the torque was not correctly selected.

The great advantage in having all bolts in a particular pattern with only minor variations from the desired tension is that each bolt is then carrying its proportion of the load. Furthermore, if the bolting machine operator—whether he is using a pre-set unit or, as is most common in this country, an impactor wrench—cuts it off when the washer is closed, chances of overstraining the anchorage are eliminated. Since the washer will begin to open when tension in the bolt drops it is possible to determine visually when bolt tension is relaxing.

In the course of investigations a number of practical points turned up. One of these was that in some cases where jagged non-uniform roof conditions existed the majority of bolts were not installed at right angles to the plane of the roof. Holes were drilled at all angles and bolt heads were rarely tightened flush with the off plate. This meant that unless the washer was bearing both against the flashing of the bolt and the roof plate it had no effect.

In some cases it was found that the washer tended to spin around as the bolt was tightened and operators could not see the split in its final position. It is suggested that where such conditions exist a small indentation should be made in the plate when it is being stamped.

It has also been found in some cases that when bolt tension has been relaxed the washer has not

shown signs of opening until the bolt has lost about 40% of its installed tension. Trials have shown that the trouble did not lie in the washers under test, but lay in elastic displacement of the bolt and the roof plate. The latter is particularly prone to do this when it is not bearing fully against the roof. Another factor in this is the friction between the surfaces of the washer and the flashing of the bolt head and the roof plate. As the tension is increased the diameter of the washer increases. In consequence only when the tension has been released sufficiently to reduce the friction between the two bearing surfaces to the point that the spring in the washer will overcome the friction will the washer open.

These last problems involved in relaxation of tension are being carefully studied and are expected to be solved in due course. In the meantime the aspect of helical spring washers being able to close at predetermined loads represents a significant development in the field of roof bolting.

# A Rhodesian Chrome Mine

A description of the Vanad mine, operated by the Rhodesian Vanadium Corporation, a subsidiary of the Vanadium Corporation of America, appears in *The Chamber of Mines Journal*, the organ of the Chamber of Mines of Rhodesia, for July. The claims from which Vanad has developed were first pegged between 1919 and 1928 and were among the thousands pegged when the chrome-ore deposits in the northern part of the Dyke were discovered. The Great Dyke is divided into four complexes, the northern complex, within which Vanad lies, being designated Musengezi and about 30 miles in length.

In the vicinity of Vanad the Dyke is characterized by a range of hills, within which mining operations take place. Chromite seams occur in serpentine, in the shape of a pitched syncline, with the wings dipping inward between about 25° to 35° towards the axis of the Dyke. The inward dip of successively lower chromite horizons becomes progressively steeper towards the margins of the Dyke, which is here about three miles wide. At Vanad the seams pitch south at 7° to 9°, are from 300 ft. to 700 ft. apart, average 4½ in. in thickness, and are subjected to minor faulting both in strike and on dip.

Within the claim area of the mine, extending across the Dyke and about two miles in a north/south direction, six seams outcrop and are locally numbered 1 to 6 from the top. Seams 1 and 2 are confined (within the mine's claim area) to the upper areas of the highest hill and both seams are now worked out right through the hill. No. 5 seam, which is badly faulted and, so far as can be ascertained, of imperfect formation, offered only isolated recovery from limited outcropping and is now not worked at all. Although mining is being developed at depth the lower limits of the seams have not yet been established, but the life of the mine on present known ore reserves is in excess of 30 years.

The chrome in the northern complex of the Dyke is of better metallurgical quality than that found further south. At Vanad it is found that the seams get friable at depth ; one possible explanation for this is that the upper levels have been cemented by the rise and fall process of the water table.

Mining proper can be said to have started in 1944, when planned development was begun on Nos. 2 and 3 seams. In 1948 power from the Electricity Supply Commission was installed and more extensive development became possible. In 1950 twin, parallel, incline shafts were started from just below No. 3 outcrop roughly in the centre of the claim area, dipping south at an incline of 18° to intercept No. 4 seam at depth. Named Keeley and Viles, after the President and a former Vice-President of the Vanadium Corporation of America, respectively, these two shafts have concrete headgears, this form of construction being decided upon for reasons of speed and economony. Both shafts were completed in 1956, Keeley to an incline depth of 3,400 ft., Viles to an incline depth of 2,800 ft. Production on No. 4 seam commenced in late 1957. West shaft, begun in 1958, dips south-east from a western limb of No. 4 seam and 40 ft. below that seam, at an incline at 30° ; depth is now about 1,400 ft. on incline.

Underground development is kept three years ahead of the mill, but looking even further—10 to 15 years—ahead work was begun last year on new twin shafts, known as Central East and Central West. These shafts, on an incline of 20° dipping north, are planned to intercept the north section of No. 4 seam at an incline depth of about 3,000 ft. and ore extraction from them is expected to start about 1965.

Mining and ore extraction is at present concentrated on parts of Nos. 3 and 4 seams from No. 3 sub-incline, Keeley, Viles, and West shafts. Some work is also being done on sundry outcrops still remaining in the northern section of No. 3 seam. Underground the seams are developed from the foot-wall. The principal method of development is by foot-wall haulages, 25 ft. below seam and on strike, at 70 ft. vertical intervals. Cross-cuts are driven to the reef at about 300-ft. intervals and hanging-wall resue stopes established, with box-holes to the cross-cuts below. Electric-powered coal drills are used, with rotary augers fitted with detachable tungsten carbide bits. The average stope advance is about 30 ft. a month and the average length of stope is 50 ft. Stope width is from 3 ft. to 4 ft., with stope tracks about 50 ft. apart. Support is carried out with waste packs, timbering, and where necessary, particularly where faults in a seam offer opportunity, small pillars are left.

Development footage of all classes to-day is of the order of 3,000 ft. per month. In 1959 a total of 22,148 ft. of main and secondary development were carried out.

The serpentine country rock provides, generally speaking, safe mining conditions, but the serpentine does exfoliate, thus creating quite a problem of keeping the mine clean. As much sorting as possible is done in the stopes themselves and all possible waste backfilled into worked-out stopes. Surplus waste and the ore, separated, are drawn through box-holes to haulage below, from where it is trammed to main shafts, thence to the surface in 3-ton skips. In general all trams 600 ft. or more from shaft haulage are hauled by storage-battery locomotive in strings of ten ½-ton (10 cu. ft.) cars. Underground three hauling shifts, with one rock-breaking shift, are worked.

Ore hoisted to the surface—in 1959 totalling 19,521 tons from approximately 15,000 ft. of stope

development and at present about 2,100 tons per month—is separated into three grades: (1) Hard lumpy, (2) friable lumpy, and (3) milling ore. The first two grades are railed from Vanad Siding, 25 miles away at Sutton mine (also owned by the Rhodesian Vanadium Corporation), to Beira for shipment direct to Vanadium Corporation's smelter in America. The milling ore is beneficiated in the mill at the mine before being shipped to America. This mill came into production in January, 1954; previous to that all ore had been shipped direct to America without treatment at the mine. Three shifts are worked in the mill.

Production at the present time, with existing facilities and equipment, is about 25% below full capacity, due to the current slack state of the chrome market. Milling ore from Sutton and Birkdale mines is also beneficiated in the mill at Vanad, a fleet of three 25-ton Leyland trucks with trailers being kept fully employed bringing milling ore from Sutton to Vanad and returning with ore for railing.

The mine suffers little or no inconvenience from water underground, pumping not more than 10,000 gallons per day; domestic water is obtained from shallow bore-holes, only 30–40 ft. deep; water for the mill is pumped from the Jackalas River three miles away. Power is obtained from the Electricity Supply Commission through three sub-stations at a cost of about £700 monthly.

# Trade Paragraphs

**Hunslet Engine Co., Ltd.,** of 125, Jack Lane, Leeds, have produced a colour-illustrated folder on their mines tractor which was described in the June issue of the MAGAZINE.

**Sturtevant Engineering Co., Ltd.,** of Southern House, Cannon Street, London, E.C. 4, in a recent folder give a number of illustrations of applications of their electrostatic precipitators with particular reference to their uses in securing clean air.

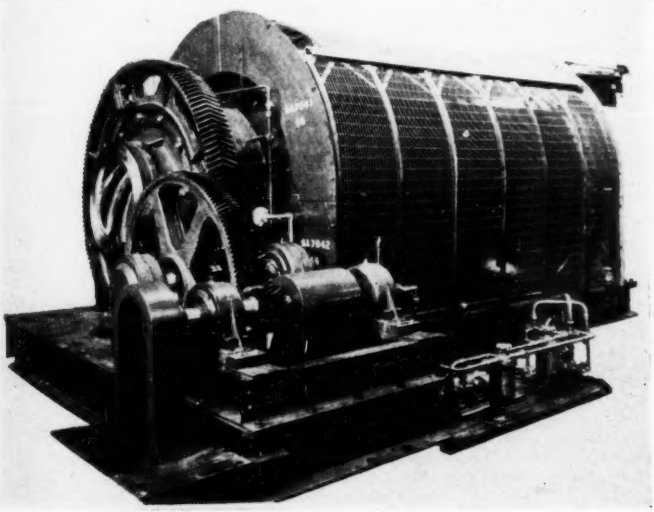
**Johannesburg Computer Service Bureau** is a company which has recently been set up jointly by Rand Mines, Ltd., and Leo Computors of London. One of the first tasks of the newly appointed manager will be, it is stated, to plan for computor operating the payroll of the thousands employed in the Witwatersrand and Orange Free State goldfields.

**Textile Improvements, Ltd.,** of 22–23 North Street, Guildford, draw attention to their *Asbestos Bulletin* in which particulars are given of the recent developments relating to this mineral. Sections on mining, processing, asbestos cement, and reinforced plastics are included in the May–June issue, which is No. 3 of the first volume.

**Visco Engineering Co., Ltd.,** of Stafford Road, Croydon, in a new fully-illustrated booklet describe water coolers. Several different types of evaporative coolers are mentioned and the purposes for which they are designed and the compilation is made more useful by the inclusiion of several pages of meteorological information and tables of other essential data.

**B.R.C. Engineering Co., Ltd.,** of Stafford, in a recent note point out that their Weldmesh is incorporated as guarding in crushing machinery, such as that shown in the illustration, manufactured by **Sheepbridge Equipment, Ltd.,** of Chesterfield. It has been found to be suitable for protecting ball and rod mills, being readily bent to the curvature required.

**Lang Pneumatic, Ltd.,** of Owen Road, Wolverhampton, refer to the production of specially-designed large-bore air cylinders which are being used in the pneumatic tipping gear for mine ore cars made by **Robert Hudson, Ltd.,** of Leeds, such as were described and illustrated in the MAGAZINE for December, 1958. During the past two years these cylinders—the largest made for this purpose—have been work-tested in Africa tipping 25-ton mine ore trucks. Recently further orders for similar



**B.R.C. Engineering Guard Screen.**

equipment have been executed and are being delivered to Hudsons for assembly and despatch to Africa.

**Soil Mechanics, Ltd.,** of 65, Old Church Street, London, S.W. 3, have recently published a number of technical leaflets. One of these describes a combined surface density and moisture meter for use where it is necessary to determine the dry density of material being compacted (as in road construction). Another gives particulars of trial pits and shafts and plate bearing tests and the methods by which these are carried out. A complete site investigation includes a corrosion survey and the method of conducting this is subject of a leaflet which is an extract from one of the company's monographs on corrosion in foundation engineering (in preparation). Finally the subject of site investigation itself is treated in another leaflet bearing this title.

**BTR Industries, Ltd.,** of Herga House, Vincent Square, London S.W. 1, announce the availability of a new flexible rubber hose—the HI-FLEX 1104—with a range of push-in end fittings. The hose is of Neoprene of flax-braid construction and offers maximum resistance to swelling and ageing. The construction is such that the push-in end fittings will " hold " without the use of conventional clamps or clips. The one-braid hose, suitable for use with push-in fittings, is available in bore sizes up to one inch and will give a working pressure of 300 p.s.i. Crimped end fittings are recommended for use with two-braid hose allowing working pressures up to 800 p.s.i. These are factory fitted and can be supplied to suit individual requirements. The push-in fittings are supplied complete with plastic end caps to protect the hose ends.

**NCK-Rapier, Ltd.,** of 32 Victoria Street, London, S.W. 1., have entered into an arrangement to be exclusive selling agents in most of the Eastern Hemisphere for the **Koehring Co.,** of Milwaukee, Wisconsin. The agreement will operate primarily for Koehring excavators and cranes, but it is expected that an extension of the activity will cover eventually road and building equipment, dumpers, and other products. NCK-Rapier, Ltd., is the selling organization for excavators and cranes made by **Newton Chambers and Co., Ltd.,** of Thorncliffe Works, near Sheffield, and by **Ransomes and Rapier, Ltd.,** of Ipswich, Newton Chambers have had a licence agreement with Koehrings for many years for the manufacture of excavators and cranes—hence the " NCK " machines, the " NC " standing for Newton Chambers and the " K " for Koehring.

**David Brown Corporation,** of Huddersfield, refer in a recent notice to the trans-Atlantic partnership formed a year ago between their company and Foote Bros. Gear and Machine Corporation, of Chicago, which has been amplified to provide new distributive arrangements for David Brown gear products in Canada and Western America. Provision for this form of co-operation was made in the initial agreement, which, besides enabling the British company to acquire a substantial financial interest in its Chicago counterpart, also embraced the pooling of manufacturing and marketing resources. A joint statement issued simultaneously in London and Chicago announces the formation in Toronto of a jointly-owned company, David Brown-Foote Gears, Ltd., which will take over the sales and distribution in Canada of gear transmission and chain products manufactured by both companies and their associates.

**Plessey Nucleonics, Ltd.,** of Weedon Road, Northampton, in conjunction with the U.K.A.E.A. have produced a portable radiation monitor capable of detecting beryllium in an aggregate containing less than 0·01% BeO. A gamma source housed in the equipment irradiates the sample and neutrons subsequently released by the beryllium are slowed down in an oil tank where they are detected by proportional counters. Transistorized, shockproof, and impervious to extremes of temperature and humidity, the equipment is powered by eight U2 type dry cells stored in the monitor. The sensitivity is such that 0·004% BeO doubles the normal background rate. Two adjustable carrying handles are fitted to the instrument to ensure that the operators are not over-exposed to irradiation. Shielding is also provided within the equipment and a display unit is mounted in a position convenient for one of the operators.

**Ruston-Bucyrus, Ltd.,** of Lincoln, in the latest number of their house magazine *The Digger* include a note under the heading " World Record " from which the following is an extract :—Bucyrus-Erie Company, our American associates, are building a mammoth stripping shovel for the Peabody Coal Company of St. Louis, Missouri. This huge machine, the 3850-B will be not only the biggest shovel in the world, it will be the largest self-power mobile land vehicle ever built.

This monster will have a dipper capacity of 115 cu. yd. and a weight of about 14,000,000 lb., and it will have a height of 220 ft. from ground to boom point and a total reach of 460 ft. The machine's power requirement will equal that of a city of 12,000 people and it will have 50 electric motors ranging from ¼ to 3,000 h.p. Its production capabilities are staggering and it will remove 36,000,000 cu. yd. of overburden annually, with a daily amount of more than twice its own weight.

**Allis-Chalmers Great Britain, Ltd.,** at their Essendine Plant, near Stamford, are now building the BTL-14D Tractoloader which is a four-wheeled rubber-tyred loader capable of fast digging, lifting, carrying, and dumping. Power reversing tractomatic transmission with a lever on the steering column to control both forward and reverse movement without stopping the machine to clutch and shift gears is one of the features. Four speeds forward are provided to 22·3 m.p.h. and four reverse speeds to 29·3 m.p.h. The transmission has an automatic clutch cut-off which disengages the clutch when the brakes are applied. It has the effect of placing the transmission in neutral, thereby diverting full engine power to the hydraulic system.

The loader is equipped with the A.E.C. 87-h.p. diesel engine. Bucket sizes available range from 1 to 3 cu. yd. capacities, choice depending on the weight of the material to be carried and the working conditions. Main distributors are **Mackay Industrial Equipment Ltd.,** Central Way, Feltham, Middx.

**Frederick Parker, Ltd.,** of Leicester, state that the largest stone crusher yet made by the company—a 40 in. by 32 in. jaw-crusher weighing 26½ tons—is now in production. The crusher has outputs of 280 tons an hour with maximum setting of 8 in. and 100 tons an hour with a minimum setting of 4 in. and incorporates several new features, including: A new type of self-aligning spherical bearing which has a bigger load-bearing capacity, facilities for flushing bearings, a simple ratchet gear for inserting and removing shims to alter jaw settings, streamlined

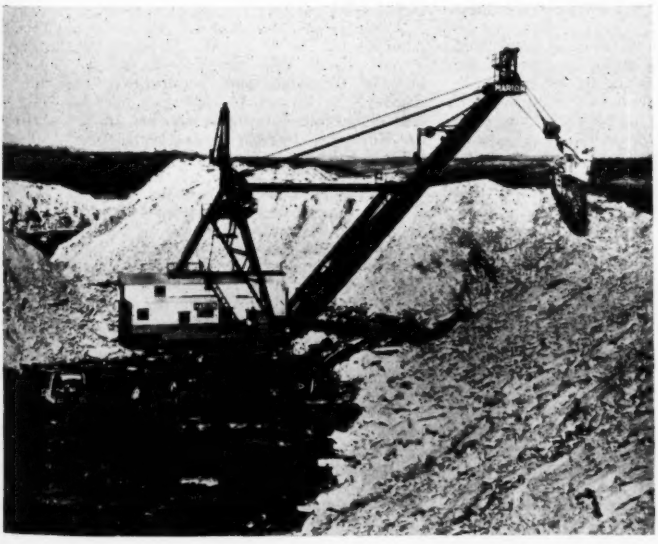
jaw fixing blocks, and split bosses on the flywheels for easy removal. The crusher, which has a fabricated steel single wall body has a single toggle action. The toggle plate ends are protected against dust by neoprene seals and are independently lubricated. The high-grade manganese-steel jaw plates are made in halves for ease of handling and are reversible end for end to give maximum working life. The crusher, which is compact for its size, is powered by a 150-h.p. diesel engine.

**Edgar Allen and Co., Ltd.,** of Sheffield announce that one of its subsidiary companies, **Buell, Ltd.,** 3, St. James's Square, London, S.W. 1, has recently obtained an order from the Lancashire Steel Manufacturing Co., Ltd., for the supply of Buell drying plant complete with Buell high-efficiency dust collectors and other ancillary equipment. The plant will handle 225 tons per hour of wet Northants ore, containing an average moisture not exceeding 18%, to be dried to a final moisture content not exceeding 12%. Buell engineers and outside staff are erecting this plant completely on the prepared foundations. Buell, Ltd., have also obtained orders from other steel companies for the supply of their high-efficiency dust collection system for the discharge end of a sinter machine and also extensions to an existing dust collecting plant just commissioned. A later announcement states they have received an order for the erection of three Buell vertical-turbo dryers, each with an output of 9½ tons per hour of china clay. The dryers will be installed at three different sites in the Cornish area and the erection of the first is due to begin in November and be in operation by next March.

**Nordberg Manufacturing Co.,** of Milwaukee, Wisconsin, (London office : 19, Curzon Street, W. 1.), in a four-page illustrated bulletin describe the Gyradisc crusher for use in the production of large tonnages of extremely fine products. This describes an entirely new method of comminution, a process of alternately impacting and releasing a thick mass of material, and also the unique feed arrangement to assure thorough mixing. The engineering features that make the Gyradisc outstanding are listed and a cross-section drawing illustrates the operation and function of the various components. The machine can operate in open circuit or in closed circuit, with fines being separated by pneumatic or mechanical methods. The ideal feed for the Gyradisc is the open-circuit product of a Symons cone-crusher containing material ranging from *minus* 1 in. to *minus* ⅜ in. As the material passes through the crushing cavity, which is composed of relatively flat crushing members, gradual reduction of the feed takes place to produce either fines, or chips and fines, depending upon the setting.

Another bulletin issued gives details of the full range of Symons primary gyratory crushers built in 30 in, 42 in., 54 in., 60 in., and 72 in. feed opening sizes for capacities from 250 to over 3,500 tons per hour. Several of these have been built in England and a 30-in. unit is operating at St. Patricks Copper Mine in Ireland.

**Blackwood Hodge, Ltd.,** of 25, Berkeley Square, London, W. 1, issue a statement that after extensive testing, both on proving grounds and actual contractor operations, the Euclid Division of General Motors, U.S.A., is now on full production of a new twin-power scraper of 14 cu. yd. struck capacity and 20 yd. heaped S.A.E. rating at 1 : 1 slope. Designated the Model TS-14, this all-wheel drive scraper is powered by two GM 4–71 engines, each with a separate Allison Torqmatic drive consisting of torque converter and 4-speed semi-automatic transmission. With converter lock-up in each Torqmatic drive maximum fuel economy is said to be achieved with efficient use of the 296-h.p. engine on grades and long high-speed hauls. All scraper operations—bowl, apron, and ejector—are hydraulically and independently controlled. The ejector is of the positive roll-out type actuated by a hydraulic jack that is identical to the apron jack.



**Marion Shovel for Iron-ore Mine.**

Two interchangeable bowl jacks are connected to the scraper bowl through heavy-duty levers and linkage.

In a more recent note issued they refer to a large stripping shovel which will shortly tower over the equipment busily engaged at the United Steel Companies' open-cast iron ore mine at Colsterworth, near Grantham, Lincs. This machine, which is being supplied by the company, will, it is stated, be the largest shovel in use outside the American continent. It has been designed by the **Marion Power Shovel Co.,** of Marion, Ohio, and part of it will be constructed by **Babcock and Wilcox, Ltd.,** at their Dalmuir Works. All assembly on site will be carried out by Blackwood Hodge and Co. The machine, which is shown here, will move 600 cu. yd. per operating hour, using a 17-cu. yd. dipper on a 145-ft. boom with a maximum cutting radius of 148 ft. 6 in. and a dumping height of 104 ft. 3 in. Power for hoist, swing, crowd, and propulsion is provided by a single 900-h.p. a.c. motor driving d.c. generators, all control equipment being grouped in the operator's cab and arranged for one man operation. As can be seen it stands on four pairs of crawler tracks which are located at each of the corners of the lower frame. A single track shoe weighs 380 lb. The pairs of tracks are mounted to the lower frame by way of hydraulic jacks, which automatically ensure that the machine remains on an even keel when operating and travelling over uneven ground.

**Johnson, Matthey and Co., Ltd.,** of 73–83, Hatton Garden, London, E.C. 1, ponit out that the ever-increasing use of printed circuits in the electronics industry has created a demand for a gold plating bath that will not only produce hard durable gold deposits but will also have no injurious effect on plastic laminates. For this purpose their newly developed Acid Hard Gold bath produces deposits of optimum durability on most grades of printed circuit and overcomes the principal defect of conventional baths—failure of the laminate bond due to the effect of the high free cyanide content of the plating solutions. Furthermore, gold electro-deposited from the new bath has a Vickers hardness in the range 120–130.

Acid Hard Gold is supplied as a concentrated solution which is diluted to make up the plating bath. Insoluble anodes of platinum or platinum-plated titanium are used in the bath. Stainless-steel anodes must not be used as corrosion of the steel leads to contamination of the solution. For like reasons the bath should be contained in glass, earthenware, or plastic vats. The recommended cleaning method is to scour the work with a stiff bristle brush, using pumice powder in water, which action will not only remove oxide film but also any traces of grease. In order to ensure good adhesion it is advantageous to deposit a thin layer of copper from a sulphate bath on work to be plated, although printed circuits with copper laminates may be plated direct. It is preferable in all cases to make the work cathodic before immersion in the bath to eliminate the possibility of chemical replacement deposits being formed.

During the plating process the pH of the bath should be measured regularly and maintained within the range 6–7 by the periodic addition of a few drops of weak phosphoric acid solution. Relatively stress-free deposits are obtained by operating the bath at 50° C. or above with a current density of not less than 3 amp./sq. ft. The weight deposited per amp.-hr. is 5·15 gm.

## RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

**35,314 of 1956 (840,803).** ELEKTROMETALLURGIE G.M.B.H. FÜR and STARCKE A.-G., H.C. Method of producing manganese of high purity.

**25,115 of 1958 (841,605).** COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION. Production of substantially pure uranium and thorium and certain binary alloys.

**37,398 of 1958 (840,162).** NEW JERSEY ZINC CO. Production of titanium.

**686 of 1959 (840,309).** METALLGESELLSCHAFT A.-G. Grate bars for travelling grates and sinter bands.

## NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

**Mineral Processing.** By E. J. PRYOR. A revised and enlarged edition of "An Introduction to Mineral Dressing." Cloth, oct., 814 pages, illustrated. Price 90s. London: Mining Publications, Ltd.

**Mathematical Tables for the Approximation of Geophysical Anomalies and Reductions by Interpolation Polynomials.** By V. A. KAZINSKII. Cloth, octavo, 94 pages. Price 35s. Oxford: Pergamon Press, Ltd.

**The General and Economic Geology of Trinidad, B.W.I.** By H. H. SUTER. Second edition, with revisionary Appendix by G. E. HIGGINS. Paper covers, 145 pages, illustrated, with maps. Price 12s. 6d. London: H.M. Stationery Office.

**Surficial Geology of the Red Deer-Settler Map-Area, Alberta.** Canad. Geol. Surv. Memoir 306. By A. MAC S. STALKER. Paper covers, 140 pages, illustrated, with maps. Price $1.25. Ottawa: Dept. of Mines and Technical Survey.

**A Guide to the Known Minerals of Turkey.** Revised by C. W. RYAN (Reprint, April, 1960). Paper covers, 196 pages, with map. Ankara: Mineral Research and Exploration Institute of Turkey.

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**Northern Rhodesia:** Annual Report of the Mines Department, 1959. Paper folio, 22 pages. Price 2s. Lusaka: Ministry of Labour and Mines.

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# Selected Index to Current Literature

*This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.*

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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